

2180
D. R. WEEMS

Railway Train Dispatching Telephone Systems



INSTRUCTIONS
FOR USE

Western Electric Company.
INCORPORATED

Railway Train Dispatching Telephone Systems



INSTRUCTIONS
FOR USE

Western Electric Company
INCORPORATED

The equipment described in this Bulletin
was designed and developed for the

Western Electric Company

by

BELL TELEPHONE LABORATORIES

CONTENTS

	<u>Page</u>
GENERAL SEQUENCE OF OPERATIONS IN CALLING A STATION..	3
CURRENT SUPPLY.....	3
Line Battery.....	3
No. 60B Vacuum Tube Rectifier.....	6
Local Battery.....	11
Way Station Battery.....	11
DISPATCHER'S SELECTOR CALLING EQUIPMENT.....	11
No. 60B Selector Apparatus Case.....	11
No. 2B Circuit Breaker.....	11
No. 221JB Relay.....	11
No. 26A Telegraph Relay.....	12
No. 152A Retardation Coils.....	13
No. 98B Protector.....	13
SELECTOR KEYS.....	14
Nos. 60A and 60B Selector Keys.....	14
Method of Setting Codes for Nos. 60A and 60B Selector Keys.....	16
Nos. 61A and 61B Selector Keys.....	17
Test Requirements for Nos. 61A and 61B Selector Keys....	18
Nos. 62A and 62B Selector Keys.....	21
Nos. 63A and 63B Selector Keys.....	21
Test Requirements for Nos. 62 and 63 Type Selector Keys..	25
WAY STATION SELECTOR EQUIPMENT.....	26
Nos. 160C and 160R Selector Sets.....	26
No. 60CG Ringer.....	28
Test Requirements for No. 60CG Ringer.....	29
No. 60AP Selector.....	30
No. 60BP Selector.....	32
Code Settings for Selectors.....	33
Test Requirements for No. 60 Type Selector.....	35
No. 60B Test Set.....	37
Selector Operate and Release Tests.....	39
Test Requirements for No. 160 Type Selector Set.....	40
No. 127J Extension Bell.....	41

CONTENTS—CONTINUED

	<u>Page</u>
NO. 60A TIME SENDING SET.....	41
Test Requirements for Nos. 149AN and R-1971 Relays.....	44
OPERATION OF SELECTOR CIRCUITS THROUGH A TRANSFORMER	44
No. 341A Transformer.....	44
No. 70A Repeating Coil.....	45
Transformer at Dispatcher's Station.....	46
Telegraph Drop at Intermediate Station.....	49
Branch Line.....	51
Simplex Bridge.....	51
Composited Phantom.....	51
TELEPHONE EQUIPMENT.....	56
Nos. 501A and B Desk Set Boxes.....	57
No. 502A Desk Set Box (Subscriber Set).....	59
TELEPHONE AMPLIFIERS.....	62
No. 100E Loud Speaker Set.....	63
Foot Switches.....	67
MAINTENANCE TESTS.....	68
Periodic Tests.....	68
Tests for Failure of Operation.....	70
Effect of Line or Wire Troubles.....	71
PARTS FOR MAINTENANCE.....	73
No. 60 Type Selector.....	75
No. 2B Circuit Breaker.....	77
No. 221JB Relay.....	79
No. 26A Telegraph Relay.....	81
No. 60 Type Selector Key.....	83
No. 61 Type Selector Key.....	85
No. 62 Type Selector Key.....	87
No. 63 Type Selector Key.....	89
No. 60CG Ringer.....	91
Dispatcher's Head Telephone Set.....	92
No. 1142AB Desk Stand.....	94
Nos. 1B, 3B, 3C and 3D Foot Switches.....	97
No. 98B Protector.....	99

LIST OF ILLUSTRATIONS

<i>Figure</i>	<i>Title</i>	<i>Page</i>
1	Schematic Circuit of No. 60B Selector Apparatus Case...	4
2	Schematic Circuit of No. 62A Selector Key.....	5
3	Voltage—Line—Selector Curves for No. 160 Type Selector Sets (No Transformer).....	6
4	No. 60B Vacuum Tube Rectifier.....	7
5	Schematic Circuit of No. 60B Vacuum Tube Rectifier...	8
6	No. 60B Selector Apparatus Case (Open).....	10
7	No. 60A Selector Key.....	14
8	No. 60E Selector Key Case.....	15
9	No. 61A Selector Key.....	18
10	No. 62A Selector Key.....	22
11	No. 63B Selector Key.....	24
12	No. 160C Selector Set including No. 60AP Selector.....	27
13	Schematic Circuit of the No. 160C Selector Set Equipped with a No. 60AP Selector.....	28
14	Schematic Circuit of the No. 160C Selector Set Equipped with a No. 60BP Selector.....	29
15	No. 60AP Selector.....	30
16	No. 60BP Selector.....	33
17	No. 60B Test Set.....	38
18	Schematic Circuit of the No. 60B Test Set.....	39
19	No. 60A Time Sending Set.....	42
20	Schematic Circuit of No. 60A Time Sending Set.....	43
21	No. 341A Transformer.....	45
22	Selector Circuit Operated Through No. 341A Transformer.....	46
23	Selector Circuit Operated Through Two No. 70A Repeating Coils in Series Aiding.....	46
24	No. 160B Condenser.....	47
25	Curves for No. 160 Type Selector Sets Operated Through No. 341A Transformer.....	48
26	Curves for No. 160 Type Selector Sets Operated Through No. 70A Repeating Coils.....	49
27	Intermediate Simplex Telegraph Drop.....	50
28	Intermediate Simplex Telegraph Drop with Voice Frequency By-Pass Repeating Coil.....	50
29	Branch Line Operated Through a Transformer.....	51
30	Composited Phantom Circuit.....	52
31	Schematic Circuit of Dispatcher's Station—Telephone and Selector Equipment.....	54

LIST OF ILLUSTRATIONS—CONTINUED

<u>Figure</u>	<u>Title</u>	<u>Page</u>
32	Schematic Circuit of Way Station—Telephone and Selector Equipment.....	55
33	Way Station—Telephone Equipment.....	56
34	Curve of Transmission Equivalent From Dispatching Station to Each Way Station.....	58
35	Curves of Transmission Equivalent at Last Way Station for Different Length of Lines and Number of Stations.....	59
36	Dispatcher's Station—Telephone Equipment.....	60
37	No. 100E Loud Speaker Set.....	63
38	Schematic Circuit of No. 100E Loud Speaker Set and Dispatcher's Station Telephone Equipment.....	64

PARTS FOR MAINTENANCE

39	No. 60 Type Selector.....	74
40	No. 2B Circuit Breaker.....	76
41	No. 221JB Relay.....	78
42	No. 26A Telegraph Relay.....	80
43	No. 60 Type Selector Key.....	82
44	No. 61 Type Selector Key.....	84
45	No. 62 Type Selector Key.....	86
46	No. 63 Type Selector Key.....	88
47	No. 60CG Ringer.....	90
48	Dispatcher's Head Telephone Set.....	92
49	No. 1142AB Desk Stand.....	94
50	Nos. 1B, 3B, 3C and 3D Foot Switches.....	96
51	No. 98B Protector.....	98

CALLING APPARATUS

— FOR —

RAILWAY TRAIN DISPATCHING TELEPHONE SYSTEMS

Instructions for Use

Western Electric apparatus is at present in general use in railway train dispatching systems. An important part of a dispatching system is the Selector Calling Apparatus. The Selector Calling Apparatus described in this bulletin enables the train dispatcher to call selectively any way station of a large number of stations on the same telephone line, without producing a signal at the other stations. It can also be used to send standard time signals to all way stations at a given time.

The functions and operation of the Selector Calling Apparatus, and the maintenance which it requires, are described in detail in this bulletin.

This Page Intentionally Blank

GENERAL SEQUENCE OF OPERATIONS IN CALLING A STATION

The sequence of operation of the various parts of the system when a call is made is as follows: A selector key operated by the dispatcher causes three groups of impulses to be sent over the line in such a manner that only the selector at the station called will be advanced to its ringing position. (Refer to Figure 1 for the sending circuit and Figure 13 for the receiving circuit.) On operating the selector key, contact K1-K3 is closed continuously and the No. 221JB Relay is operated, connecting the main battery through the contacts of the No. 26A Relay and the two No. 152A Retardation Coils to the line wires L1 and L2; also, the key contact K1-K2 is closed intermittently, operating the pole-changer relay (No. 26A) to send a sequence of reverse impulses to the line. This sequence of impulses, while operating all selectors on the line, will advance only the code wheel of the selector at the station called so as to close its local bell circuit. The bell at that station will ring for about two seconds, then another impulse from the calling key will release the selector and open the bell circuit. While the bell is ringing a tone or answer-back will be heard in the receiver notifying the dispatcher that the bell is ringing.

CURRENT SUPPLY

The current supply for this system consists of a line battery of 150 to 400 volts D.C. and a local battery of 12 or 24 volts

D.C. at the dispatcher's station and a 4-volt D.C. battery at each way station.

Line Battery

The line battery furnishes the current for operating the selectors at the way stations. The voltage required depends on the loop resistance of the line wires and the location and number of selector sets on the line. For standard circuits (using No. 160 Type Selector Sets with condensers in the sets) the voltage required for normal operation can be determined from the voltage-line selector curves of Figure 3. For transformer or repeating coil circuits the voltage required for normal operation can be determined from the curves given in Figures 27 or 28. These curves show the voltage required for different length lines of No. 9 B. & S. copper wire—8.3 ohms per loop mile—equipped with selector sets uniformly distributed. The voltage specified for normal operation is higher than the minimum operating voltage required. This insures the operation of the selectors when the line insulation is low during wet weather and allows for a slight decrease in the potential for any reason. The potential should in no case be allowed to decrease more than 15 per cent.

Dry cells, storage cells, a motor-generator set or a Western Electric No. 60B Vacuum Tube Rectifier may be used for this line current source. When dry cells are used, frequent measurements should be made to determine the potential of the battery when the current is flowing under operating conditions. This is necessary because the gradual increase in internal resistance of the dry cells

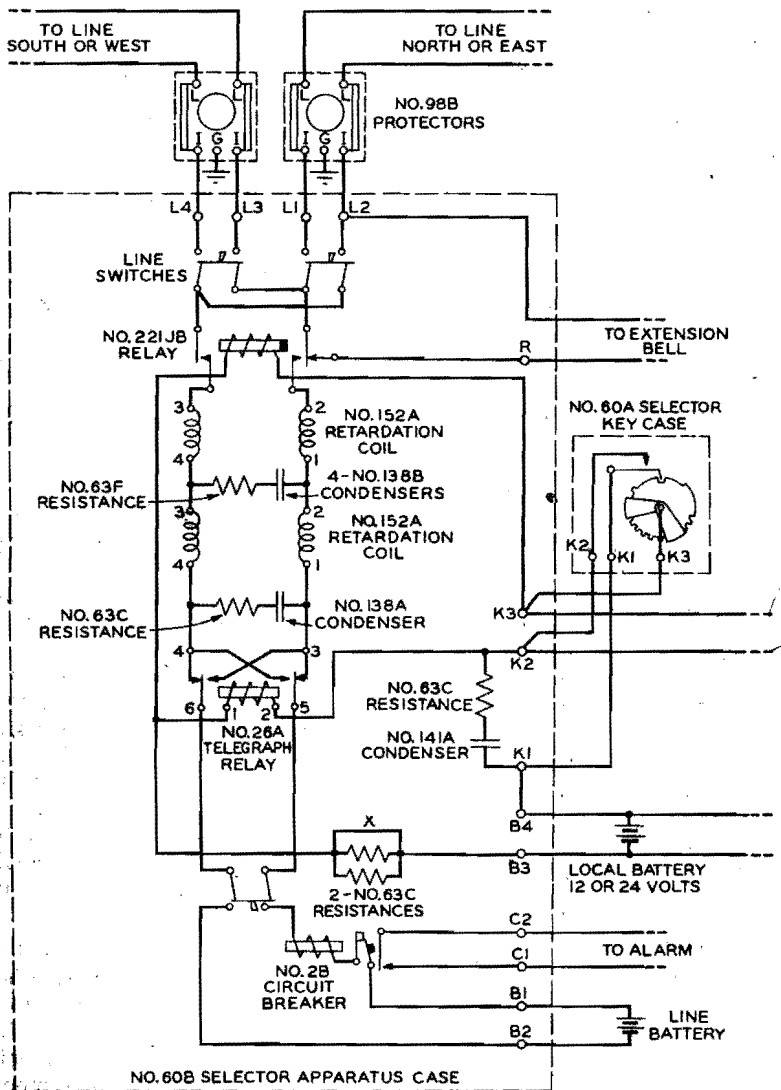


Figure 1—Schematic Circuit of No. 60B Selector Apparatus Case

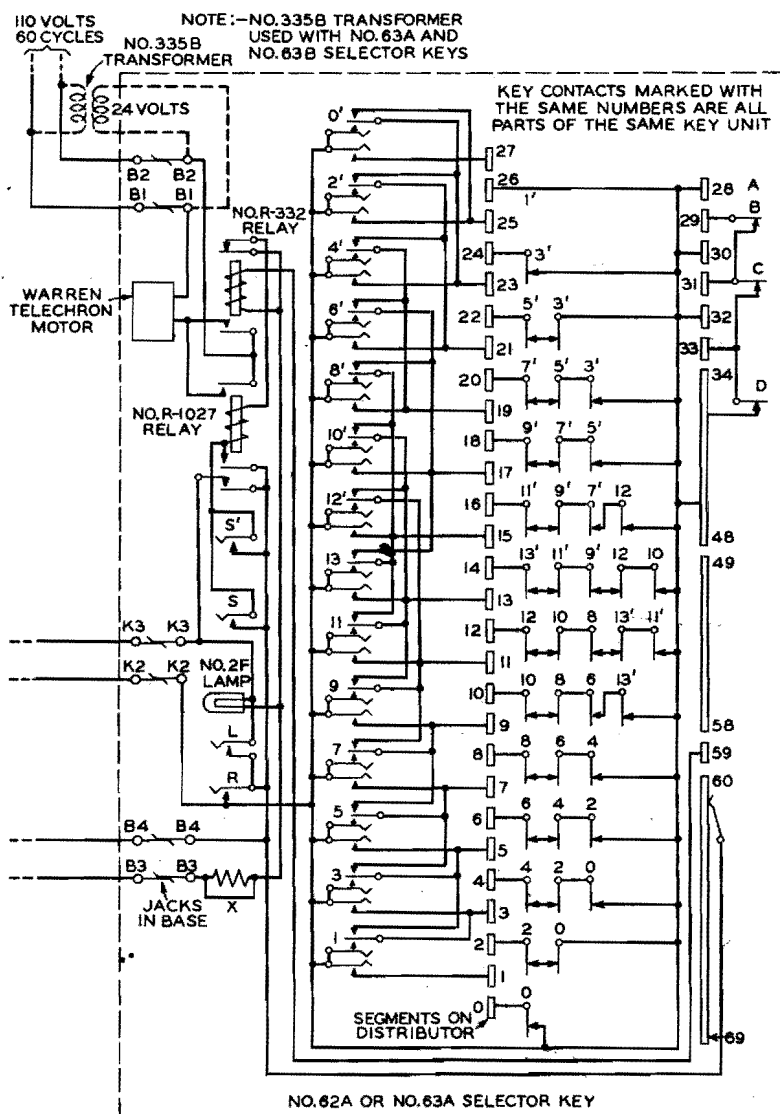


Figure 2—Schematic Circuit of No. 62A Selector Key

will lower the voltage available for operating the selectors.

No. 60B Vacuum Tube Rectifier

The No. 60B Vacuum Tube Rectifier, Figure 4, is operated from a 110-volt, 60-cycle, alternating-current source and may be used instead of dry cells, storage cells, or a motor-generator set, to furnish the line battery for operating one or two selector circuits. It does away with the periodic tests of dry cells, the charging of storage cells or the continuous large power drain of the motor-generator sets.

The rectifier consists of a fuse-and-switch block, No. 72A Repeating Coil, No. F11 Relay, 11 No. 138B Condensers, vacuum tube socket for mounting the

Western Electric No. 214E Vacuum Tube, and a terminal block all mounted in a black finished sheet steel box 18 inches high, 12 inches wide, and 6½ inches deep. It weighs approximately 60 pounds.

The 110-volt, 60-cycle, alternating current is connected through the switch block and the two (6 ampere) fuses to the primary of the repeating coil (see Figure 5). The secondary of the repeating coil is provided with taps (terminals S1-S6) for varying the direct current voltage output of the set at terminals B1 and B2 from 60 to 540 volts potential in approximately 60-volt steps. To obtain these values the two flexible leads (black and green) to the No. 72A

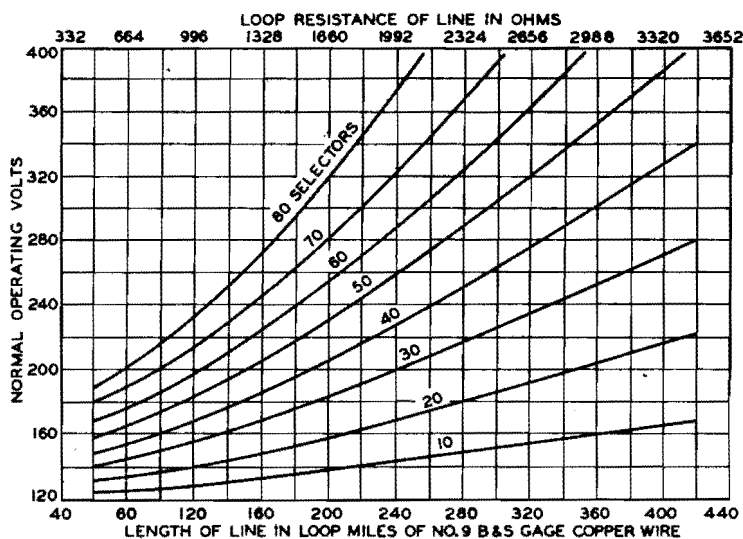


Figure 3—Voltage—Line—Selector Curves for No. 160 Type Selector Sets (No Transformer)



Figure 4—No. 60B Vacuum Tube Rectifier

Repeating Coil should be connected to the following terminals:

S1 and S2 for 60 volts
S2 and S3 for 120 volts
S1 and S3 for 180 volts
S2 and S4 for 240 volts
S1 and S4 for 300 volts
S2 and S5 for 360 volts
S1 and S5 for 420 volts
S2 and S6 for 480 volts
S1 and S6 for 540 volts

The taps permit adjustment of the D.C. voltage output of the rectifier to the needs of the circuit as required for the selector circuits with which it will be used. The above values of the output voltage will be obtained with light loads; for greater line loads these values will be reduced up to 25 per cent for maximum line loads. Under maximum load conditions,

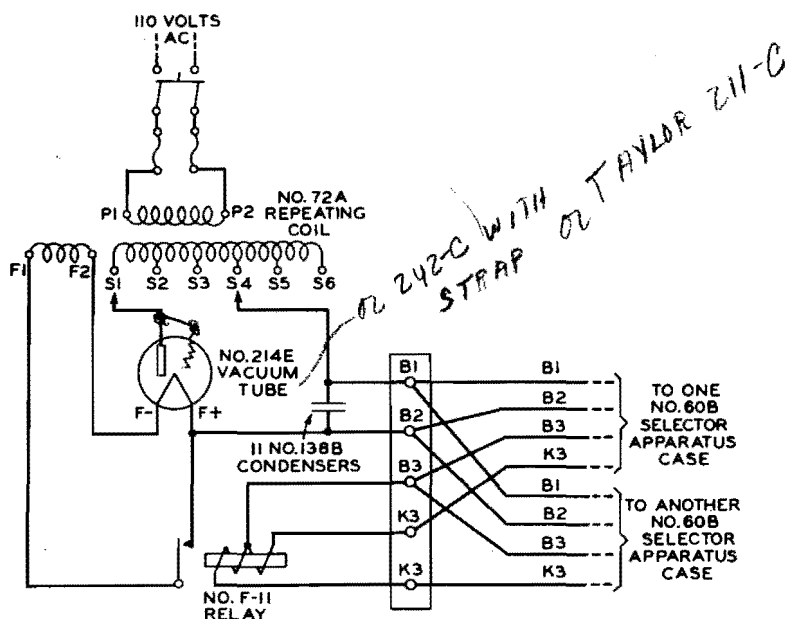


Figure 5—Schematic Circuit of No. 60B Vacuum Tube Rectifier

the maximum direct current output is approximately 0.300 ampere at 400 volts potential.

The No. 214E Vacuum Tube which is required for the operation of this rectifier is not furnished as a part of this set and must be ordered separately. The No. 214E Vacuum Tube is a two-element tube used for half-wave rectification. The tertiary winding of the repeating coil supplies 10 volts potential to heat the filament. The filament current should be 3.25 ± 0.15 amperes. The filament circuit is completed only when the F11 relay is energized by the operation of a selector key and is closed a second

before calling impulses are sent out automatically by the key. This allows the filament to heat sufficiently so that the first impulse for operating the selectors will be a full potential impulse. The average life of the No. 214E Vacuum Tube, based on 200 to 300 calls per day, is approximately two years. This life is with a filament current of 3.25 ± 0.15 amperes. If the current is increased above this value, the life of the tube is shortened.

The No. 138B Condensers, approximately 15 microfarads capacity, bridged across the output terminals of the set are charged during the rectifying half-wave

period of the tube and then discharged during the non-rectifying half-wave period into the selector line and thus aid in maintaining the D.C. voltage output during the latter period.

The No. F11 Relay has a single make contact which is for the purpose of completing the filament circuit of the No. 214E Vacuum Tube when a selector key is operated, so that the direct current potential is delivered to the output terminals of the set only while a selector key is operating.

The relay has two windings of 55 ohms each so that it may be operated by the selector keys of two selector systems separately or at the same time. The relay should receive from 0.150 to 0.220 ampere of current through either winding for normal operation. For testing purposes the relay should operate on a minimum test current of 0.075 ampere through either winding after the following adjustments have been made:

The air-gap between the contact springs when the relay is not operated should be minimum 0.010 inch and the air-gap between the armature and core should be 0.015 inch. The contact pressure of the outer contact spring should not be less than 10 grams against its stop. The contact pressure of the spring tensioned against the armature stud should be sufficient to hold the armature against the adjusting nut.

The terminal block has five terminals for outside connection as follows: B1, B2 and B3 to be connected to B1, B2, B3 of one

or two No. 60B Selector Apparatus Cases. One K3 to be connected to the K3 terminal of one No. 60B Selector Apparatus Case and a second K3 to be connected to the K3 terminal of the second No. 60B Selector Apparatus Case when used.

When using the No. 60B Rectifier as the line battery supply, and operating the selectors through a transformer or repeating coil the line contacts of the No. 221JB Relay in the No. 60B Selector Apparatus Case should be strapped so as to bridge the normally open contacts of the relay. This circuit arrangement allows the condensers bridged across terminals B1 and B2 of the rectifier to become discharged at the end of a call through the 2000-ohm resistance in the transformer or repeating coil circuit and thus prevent the possibility of two preliminary pulses through the selectors on the next call.

The set rectifies only when the filament of the tube is lighted. This decreases the drain on the alternating current source during the non-calling period. The drain during non-calling periods when the filament circuit is open is 8 watts and on the average selector circuit the drain is approximately 90 watts while calling. At the rate of 300 calls per day (8 seconds per call) the rectifier would require 250 watt-hours per day.

When the local battery connected to the B3 and B4 terminals in the No. 60B Selector Apparatus Case is 24 volts instead of 12 volts, a 50-ohm resistance should be connected in series with the leads connecting to the K3 terminals of the rectifier set.

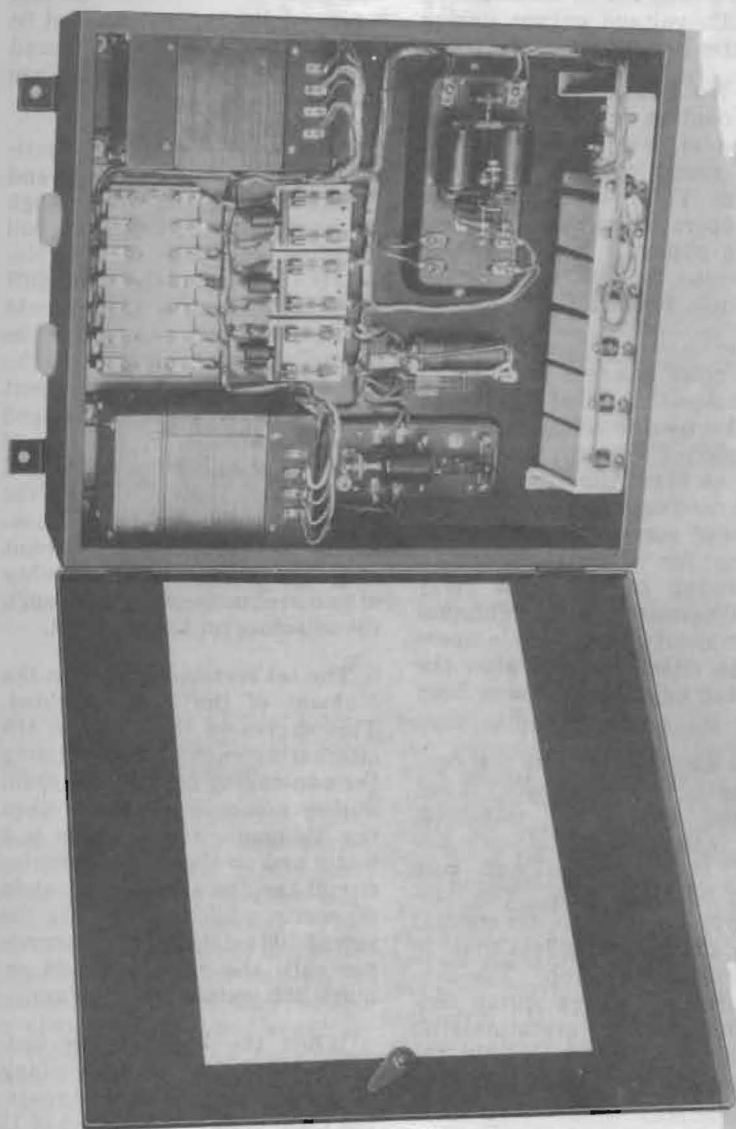


Figure 6—No. 60B Selector Apparatus Case (Open)

Local Battery

The local battery at the dispatcher's station (Figure 1) furnishes current for operating the No. 26A and No. 221JB Relays. Dry cells or sufficient storage cells to give a voltage of 12 or 24 volts should be used. In no case should the voltage of this battery be allowed to decrease to less than 8 volts.

Way Station Battery

The way station battery (Figure 13) furnishes current for operating the No. 60CG Ringer. It may consist of primary or secondary cells. The voltage of this battery should be from 3 to 5 volts. The transmitter battery of the way station telephone sets may be used as a common battery for the telephone transmitter and for the ringer of one or two selector sets.

DISPATCHER'S SELECTOR CALLING EQUIPMENT

NO. 60B SELECTOR APPARATUS CASE

This case (Figure 6) contains all the calling apparatus at the dispatcher's station except the selector keys in ordinary installations. It is a metal cabinet approximately 18 inches high by 16 inches wide by 6½ inches deep, arranged for wall mounting. It is completely wired and provided with terminals for connecting the battery, line wires and selector keys as shown in Figure 1. A short description of the apparatus contained in it follows:

No. 2B Circuit Breaker

The function of the No. 2B

Circuit Breaker is to open the main current supply lead if an excessive amount of current flows from the main battery.

The resistance of the circuit breaker is 2 ohms and it is normally adjusted to operate on 0.6 ampere and not to operate on 0.4 ampere. These values can be increased or decreased by adjusting the air-gap between the armature and the magnet by means of a knurled nut at the extreme end of the magnet. The best setting for the circuit breaker will depend somewhat on the local conditions for each installation.

The circuit breaker when operated closes a local contact C1-C2 (Figure 1). Any local alarm circuit can be connected as desired to terminals C1-C2.

On resetting the circuit breaker after it has been operated, care should be taken not to hold it in forcibly by hand, so that, if the trouble is still on the line, the circuit breaker will have an opportunity again to open the circuit.

No. 221JB Relay

The function of this relay is to connect the sending circuit to the line at the beginning of the operation of the selector key, and to disconnect the sending circuit again at the end of the operation of the selector key.

This relay is operated by the local battery through the closure of the K1-K3 contact of the selector key. This relay should remain operated during the whole operation of the key.

The relay also has a normally closed contact that may be used for connecting an extension bell

across the line as indicated in Figure 1.

The resistance of the relay is 335 ohms and it should receive from 0.024 to 0.036 ampere of current under normal operating conditions.*

***CAUTION:** Before attempting to adjust the relay the main battery switch should be opened.

Testing Requirements

(See Figure 41—Page 78)

For testing purposes the relay should operate on a current of 0.018 ampere and not operate on a current of 0.015 ampere after the following adjustment is made.

There should be an air-gap of 0.036 inch between the contacts of each set of normally open contact springs (J-K) and (K-L) when the relay is in the unoperated position.

No. 26A Telegraph Relay (Pole Changer)

The function of this relay is to reverse the polarity of the main battery so that each succeeding impulse sent over the line is in the opposite direction to the preceding one. This relay is operated by the local battery through the closure of the K1-K2 (Figure 1) contact of the selector key.

The resistance of the relay is 25 ohms and it should receive from 0.320 to 0.480 ampere of current when operating under normal conditions.

Testing Requirements

(See Figure 42—Page 80)

For testing purposes the relay should operate on a current of

0.160 ampere after the following adjustments are made.*

The air-gap between the contacts of the middle spring (M) and the contacts of the contact screw (O) should be approximately 0.045 inch when the relay is in the operated position. When the relay is in the unoperated position the air-gap between the contacts of the middle spring (M) and the contacts of the front spring (L) should be approximately 0.030 inch.*

***CAUTION:** Before attempting to adjust the relay the main battery switch should be opened.

The air-gap between the bone studs (N) in the armature and the middle contact springs (M) should be 0.030 inch when the relay is in the unoperated position.

The air-gap between the armature (K) and the cores should be approximately 0.020 inch when the relay is in the operated position.

The contact pressure between the contact points should be approximately 35 grams in each case with the relay in the operated or unoperated position.

To keep the sparking of the contacts at a minimum it is important that the two front contacts make or break at the same time and that the two back contacts make or break at the same time. Also when the relay is operated under normal circuit conditions by the short impulses from the selector key the time elapsing while the front contacts are made should equal the time the back contacts are made, so that the time the potential is

held on the line for each reversed current impulse will be equal. This can be determined quite closely by observation but more accurately by use of a zero center-scale voltmeter or a zero center-scale milliammeter with a resistance to limit the current. For this test the meter should be connected directly across the line wires. In either case the swing of the needle for the short impulses from the selector key should be the same amount each side of the center point. This shows, for example, that the positive impulses are of the same duration as the negative impulses. If this test shows that the positive and negative current impulses are not equal, the magnets of the No. 26A Relay should be adjusted by means of the knurled nut at the end of the magnets. Increasing the magnetic air-gap will decrease the time during which the front contacts are made. Decreasing the magnetic air-gap will increase this time.

No. 152A Retardation Coils and 4 No. 138B (1 1/4 mf) Condensers

The function of these coils and condensers is to smooth out the impulses of current used for operating the selectors while calling, so as not to cause an objectionably sharp click in the receiver, but merely a dull thump that is not objectionable and does not interfere with the telephone transmission.

The resistance of these coils is 20 ohms each or a total of 40 ohms for the two coils.

The Nos. 138A and 141A Condensers with resistances are for spark "take-up".

No. 98B Protector

The No. 98B Protector (Figure 51, page 98) replaces the No. 58BP Protector formerly used and consists of a single porcelain base on which are mounted:

- 2—No. 11C Fuses—7 ampere.
- 2—No. 26 Protector Blocks—Hard Carbon.
- 2—No. 30 Protector Blocks—Porcelain with carbon insert.

The function of the protector is to protect the inside apparatus against damage from high voltages by providing a shunt path from each side of the line through an air-gap between the blocks to a well established ground connection. It is important that this ground connection be well and permanently made. A fuse in each side of the line is also provided to guard against abnormal currents. Seven-ampere fuses are generally used.

The spacing between the blocks is such that a breakdown will occur on an average of 700 volts. Thus a low-impedance path is provided to lead the high voltages off to ground rather than through the calling or telephone apparatus. Damage to the apparatus is thereby avoided.

The No. 98B Protector should be connected between the station apparatus and the line wires as shown in Figures 1, 31 and 32. The fuses should always be connected on the line side, and the blocks on the station side.

If the blocks become grounded by lightning or other high voltages, they should be replaced by new ones.

SELECTOR KEYS

The function of the selector key is to control the operation of the stick relay (No. 221JB) and the pole-changer relay (No. 26A), so that the necessary sequence of current impulses to operate the selector at the station desired will be transmitted to the main line wires (See Figures 1, 31 and 32).

There are three types of keys that may be used: (1) the No. 60 Type Selector Key (Figure 7) requiring an individual key for each selector, (2) the No. 61 Type Selector Key (Figure 9) provided with lever arms for setting the code as required when making a call, and (3) the Nos. 62 and 63 Type Selector Keys (Figures 10 and 11) provided with push-button keys for setting the code as required when making a call.

NOS. 60A AND 60B SELECTOR KEYS

The No. 60 Type Keys (Figure 7) are individual keys having a clock spring operating an impulse wheel through a train of gears, with the speed controlled by a governor.

The keys are mounted in oak cases (Figure 8) coded the Nos. 60A, B, C, D and E Selector Key Cases for mounting 24, 36, 48, 60 or 12 No. 60A or No. 60B Selector Keys or No. 50A Selector Key Spaces, respectively.

The keys can easily be removed from the key cases with a screw-driver by turning the screw under the handle counter-clockwise. The keys, when mounted, make contact with the springs in the back of the key case. These springs are connected with the binding posts marked K1, K2,

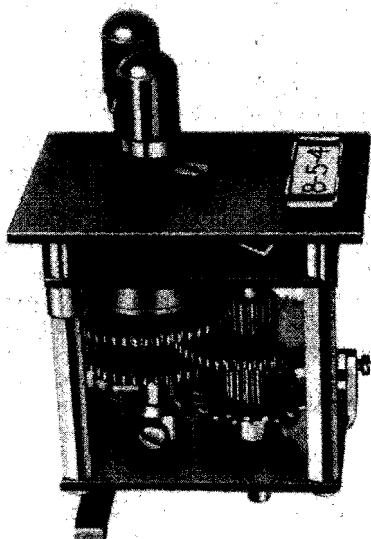


Figure 7—No. 60A Selector Key

K3, at one end of the key case. When a key is operated by turning the handle one-quarter turn and then releasing, it returns automatically to its normal position. The speed at which it returns is regulated by a governor which can be adjusted by bending in or out the springs carrying the governor weights to increase or decrease respectively the speed of the key.

The No. 60A Selector Key is for use with the No. 60AP Selector when set for the code numbers given in Table I (Page 33). It may be set for any of the code numbers given in Table I by adjusting its segments as described in detail hereafter. In this series of settings the total number of current impulses for any code is seventeen.

The No. 60B' Selector Key is for use with the No. 60AP Selec-

tor when set for the code numbers in Table II, (page 34) and with the No. 60BP Selector when set for the code numbers given in Table I for the No. 60BP Selector. It may be set for any of the code numbers given in Table II or I, by the adjustment of its segments in a manner similar to that explained in detail for the No. 60A Selector Key, with the exception that the total number of impulses is increased by 10 for the 27 step code settings of the

No. 60AP Selector and that a flat segment is used to reduce the total number of impulses to 17, 19, 21 or 23 for the A, B, C and D contacts for the 17-step No. 60BP Selector.

TEST REQUIREMENTS FOR THE
NOS. 60A AND 60B SELEC-
TOR KEYS. (See Figure 43—
Page 82.)

In normal position there should be a clearance of minimum 0.010 inch between the end of the inner



Figure 8 No. 60E Selector Key Case

contact spring (F) and the impulse wheel (A) and the spring should extend minimum 0.015 inch in side of the slot towards the center of the wheel.

The pressure of the inner contact spring (F) at the bottom of a tooth should be minimum 10 grams and at the top of a tooth maximum 110 grams including the pressure of the outside contact spring (E) when the key is in the operated position.

The contact pressure between the two contact springs (E and F) when the inside spring is pressing on the top of a tooth should be minimum 15 grams.

These two springs should be so adjusted that the duration of make will be 50 per cent and the duration of break 50 per cent of the time required for passing over each tooth of the wheel. This, of course, does not include the time while the spring is passing over the large segments. The duration of closure of these contacts can be determined by connecting the terminals K1-K2 in series with a voltmeter and across the battery. Then the average reading of the meter needle, while the contact springs are passing over the small teeth of the impulse wheel, should be one-half of the steady reading of the meter while the contact is held closed by hand or is short-circuited.

The tension of the main spring (M) should be such that a force of maximum 98 inch-ounces, minimum 60 inch-ounces, will be required to hold the main shaft at rest at a point approximately 45 degrees from its normal position.

All bearings, worm, pinions, and pinion shafts should be ade-

quately lubricated with No. 3 spindle oil or its equivalent once in every three months. The governor weights should not be lubricated.

The governor springs for the No. 60A Selector Key should be so adjusted that the impulse wheel will make one revolution in not less than $7\frac{1}{2}$ seconds and not more than 8 seconds.

The governor springs for the No. 60B Selector Key should be so adjusted that the impulse wheel will make one revolution in not less than 9 seconds and not more than $9\frac{1}{2}$ seconds.

Method of Setting Codes for Nos. 60A and 60B Selector Keys

In setting the segments on the impulse wheel of the key, each closure of the contacts counts one and each opening of the contacts counts one. Two styles of segments are provided, one a flat segment which closes the contacts while the inner spring passes over it, the other segment with a bent-up part which engages with the insulated piece on the outer spring, raising this spring sufficiently to keep the contacts open while the outer spring passes over.

Each key requires two segments to give the three sets of impulses. If the first number in the code is odd, a flat segment is required, while a segment with the bent-up part is required if the first number is even. If the last number in the code is even, a flat segment is required, while a segment with the bent-up part is required if the last number is odd. Thus two like segments or one of each kind may be required to give the code setting. The first segment is set

so that the inner contact spring, in passing over the first set of teeth on the impulse wheel, gives the number of closures and openings of the contacts represented by the first number in the code. The other segment is set so that the contact springs, in passing over the third set of teeth on the impulse wheel, give the number of closures and openings of the contacts as represented by the last number in the code. Since the total number of impulses for any three code combination is always the same in the same table, it follows that if the first and the last numbers are correctly set the middle one will be automatically determined.

For example, to set the No. 60A Selector Key for selecting station 8-5-4, begin at the first tooth and count 8 (first number in code) in a clockwise direction, counting one for each tooth and one for each space, in this case 4 teeth and 4 spaces. As the last count was a space, set the segment with the bent-up part so as to keep the contact in the same position while passing over the segment, as on the last count. This segment is set approximately flush with the edge of the tooth, so that the outside contact spring will be off this segment before the inner contact spring strikes the next tooth.

To set the other segment, begin at the ringing position and count 4 (last number in code) in a counter-clockwise direction, counting one for each space and one for each tooth, in this case two spaces and two teeth. As the last count was on a tooth, set the edge of a flat segment on the center of this tooth. The number of closures and openings of

the contact while the inner contact spring passes between the two segments, is the middle number in the code (5 in this case).

To set the No. 60A Selector Key so that all No. 60AP Selectors will be advanced to their time receiving position, place a flat segment bridging from the center of the first tooth to the center of the fourth tooth. This gives, after the first long impulse, 22 regular impulses in succession.

The No. 60B Selector Key is set in a similar manner except the total number of impulses is 27 for the station codes (Table II) and 32 total impulses for time sending.

NOS. 61A AND 61B SELECTOR KEYS

The No. 61A Selector Key (see Figure 9) is for use as a master key at test and switchboards; also at way stations on intercalling circuits. It may be set for any of the code numbers given in Table I, page 33, for all selectors set for the 17-step code by moving the levers, extending through the cover, to the code desired. As in the case of the No. 60 Type Keys, the middle number of the code is automatically determined by setting the first and the third numbers.

The first lever on the left side is used only with the No. 60BP Selector and normally is placed for station A and should be left in this position when used in connection with the No. 60AP Selectors. When used with the No. 60BP Selectors it should be moved to the B, C and D position, corresponding with the code of the station desired.

To make a call, the second lever is placed opposite the first number of the code of the selector desired. The third lever is placed opposite the last number of the code of the selector desired. The right hand lever is then moved down to the bottom of its slot and released. The key then operates to give the same sequence of impulses as the No. 60A Selector Key set for the same code.

The No. 61A Selector Key may be set to call all stations on the line equipped with No. 60AP Selectors (17-step) and all stations connected to the A contact of the No. 60BP Selectors (17-step) by setting the second and third levers each on zero. The key then sends out 17 consecutive impulses to step all selectors to the first ringing contact.

Three terminals on the bottom, designated K1, K2 and K3, connect to the corresponding terminals in the No. 60B Selector Apparatus Case (Figure 1). The contact springs connecting to K1 and K2 terminal should be adjusted to be closed 50 per cent of the time as the key is operated. This may be determined by the method explained under the No. 60 Type Selector Key (page 14).

The No. 61B Selector Key is similar to the No. 61A Selector Key except it is arranged for the code numbers given in Table II (page 34) for selectors set for the 27-step code.

TEST REQUIREMENTS FOR NOS. 61A AND 61B SELECTOR KEYS (See Figure 44—Page 84)

The main spring (S) should be

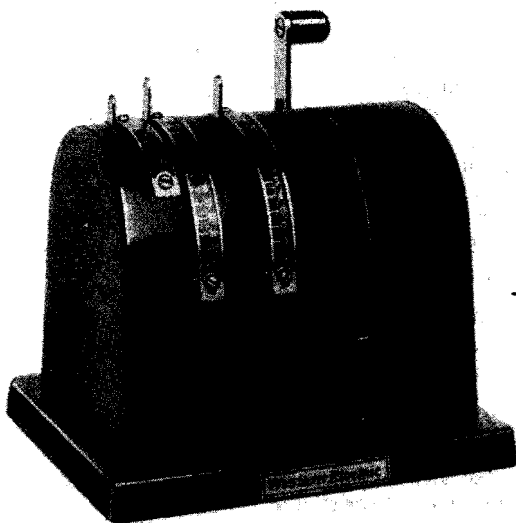


Figure 9—No. 61A Selector Key

wound sufficiently so that it will reliably drive the main shaft one revolution when the operating lever (AA) is operated to its extreme forward position and released.

The pawl spring (Q) should exert sufficient pressure on the pawl (P) to insure that the pawl will reliably engage the ratchet wheel (R) at all times.

When the operating lever (AA) is operated to its extreme forward position the pin in the segment gear, attached to (AA) should disengage the latch approximately $\frac{1}{16}$ inch from the notch in the governor gear (U) so that on releasing the operating lever, the main shaft is free to be driven one complete revolution. At the end of one revolution the latch should drop in the notch in the governor gear and stop the shaft and associated apparatus.

The locking spring (I) in its normal position should press against the teeth of the impulse wheel (R) with a minimum pressure of 150 grams, and should be adjusted lengthwise so as to position the impulse wheel (R) and the ratchet wheel (R) so that the pawl (P) on leaving the fixed segment (AD) should engage the ratchet wheel at approximately the center of a tooth, with a minimum pressure of 10 grams.

NOTE—In the normal position of the locking spring the crimps of the spring should lie between two teeth.

The upper contact spring (J) should be adjusted lengthwise so that the bearing spring (J) should engage evenly in the space be-

tween the teeth of the impulse wheel (R) and press against the same with a pressure of approximately 10 grams when the impulse wheel is in its normal position.

The lower contact spring (L) should in its normal position, be held down by the stud connected to the main shaft so that it does not make contact by at least $\frac{1}{32}$ inch with the middle (K) or upper (J) contact springs in any position of the impulse wheel (R).

While the key is operating, the lower contact spring (L) should make a positive and non-interrupted contact with the middle contact spring (K) and should press against the end of the stop spring, except when depressed by the upper contact spring (J).

The middle contact spring (K) in its normal position should press against the stop spring, with a pressure of approximately 5 grams measured at the end of the spring, and while the key is operating this spring should be raised by the lower contact spring (L) so as not to touch the outer end of the stop spring.

The upper (J) and lower (L) contact springs should be adjusted to make contact as the impulse wheel (R) revolves so that the duration of the make should be 50 per cent and the duration of the break 50 per cent of the time required for passing over each tooth of the impulse wheel. The contact pressure between these two springs when in contact should not be less than 15 grams.

The pawl (P) should be located, when in its normal position, so that its arm will rest on the

fixed segment (AD) approximately midway between the upper edge of the notch (for releasing impulse) and the upper edge of the fixed segment.

The three position springs (AC) should press against the tooth part of their respective movable segments, with a minimum pressure of 200 grams.

The position springs (AC) should be adjusted so that the movable segments (A), (B) and (R), when set according to the numbers on the cover, will control the impulse wheel (R) in such a manner that the opening and the closing of the main contact springs (J) and (L) should correspond to the code setting.

The movable segments, (A), (B) and (R) should be adjusted so that when the arm of the driving pawl (P) passes over them, the pawl will be disengaged from the ratchet wheel (R) and will not move the ratchet wheel ahead a partial step in coming up on the segments. As the pawl leaves the movable segments, it should engage approximately the middle of the sixth succeeding tooth in such a manner that the impulse wheel will be advanced only in full steps, that is, from a notch to a tooth, or vice versa, or a multiple of that distance.

As the arm in the pawl (P) passes over the notch in the fixed segment (AD) the impulse wheel (R) should advance one step and open the main contacts (J) and (L). This is called the releasing impulse and is not counted in the code.

Each code plate on the cover should be so located that the lines

opposite the figures will be approximately at the center of each lever arm respectively.

The moveable segments (A), (B) and (R) should be adjusted so that the arm of the driving pawl (P) will pass over them without advancing the segments from their set positions.

There should be a clearance of approximately 0.050 inch between the tip of the pawl (P) and the teeth of the ratchet wheel (R) when the pawl arm rides over the fixed segment (AD).

The interlock arm (C) should be adjusted on the middle movable segment (B) to engage the handle part of the right-hand movable segment (R) in such a manner that it will be impossible to set the two segments so that the sum of the two numbers set will be greater than 17 for the No. 61-A Selector Key, and 27 for the No. 61B Selector Key. In attempting to set the movable segments to a number greater than 17 or 27, either segment should move the other segment correspondingly, the interlock arm should also be adjusted so as to allow the driving pawl to pass under with not less than $\frac{1}{32}$ inch clearance and to clear the under part of the cover by not less than $\frac{1}{32}$ inch.

The No. 61A Selector Key should be adjusted to make one complete operation in $7\frac{1}{2}$ to 8 seconds. The speed is changed by bending the governor springs, at the right end, in to increase and out to decrease the speed. The No. 61B Selector Key should be adjusted to make one complete operation in 9 to $9\frac{1}{2}$ seconds.

NOS. 62A AND 62B SELECTOR KEYS

NOS. 63A AND 63B SELECTOR KEYS

These selector keys are master calling keys arranged to operate any or all selectors on a line to their ringing positions by pushing one locking key in each of two groups of keys.

The Nos. 62A (Figure 10) and 62B Selector Keys are arranged for desk or table mounting, and the main apparatus unit is arranged so that it can be removed from its base by means of a jack connection (see Figure 45, page 86). The overall dimensions are approximately $12\frac{1}{2}$ inches high, $10\frac{1}{4}$ inches wide, $6\frac{1}{2}$ inches deep. The metal frame and cover are finished in black.

The Nos. 63A and 63B (Figure 11) Selector Keys are arranged for mounting in the face equipment of a No. 604 PBX Switchboard between the stiles ($10\frac{1}{4}$ inch face mounting) and are arranged so that they may be removed from the face equipment of the switchboard either from the front or rear. The metal frame and cover are finished in aluminum. The overall dimensions of the keys are approximately $10\frac{3}{8}$ inches high, $9\frac{3}{4}$ inches wide, $6\frac{1}{4}$ inches deep.

The Nos. 62A and 63A Selector Keys provide means for calling all selectors in the 17-step selector code as given in Table I. These keys have two groups of 14 keys each and one group of 7 keys.

The Nos. 62B and 63B Selector Keys provide means for calling all selectors in the 27-step selector code as given in Table II. These

keys have two groups of 21 keys each and one group of 7 keys.

Each selector key also has a distributor panel with a Telechron motor driving a brush arm, carrying a brush which wipes over a commutator consisting of 70 small segments (Figure 45). On the front of this panel a designation card is provided for listing the keys to be operated to make the selector call for each station. A lamp is also mounted on this panel to indicate when the key is operated.

110-120 volts, 50-60 cycles is required for the operation of the Telechron motor used in these selector keys and is connected directly to the terminals in the base of the Nos. 62A and 62B Selector Keys, or through a No. 335B Transformer for the Nos. 63A and 63B Selector Keys. For the Nos. 63A and 63B Selector Keys, the No. 335B Transformer must be ordered separately and is used to step down the voltage to 24 volts so as not to require special insulation in the wiring for the keys in the PBX switchboard. The selector keys are arranged to use either 12 or 24 volts D.C. for the local operation of the relays and lamp. When a 24-volt battery is used, the strap marked "X" (Figure 2) shunting the 45-ohm resistor must be removed.

The schematic circuits (Figures 1 and 2) show the method of connecting the Nos. 62 and 63 Type Selector Keys with the No. 60B Selector Apparatus Case. These keys are interchangeable with the Nos. 60 and 61 Type Selector Keys and may be connected in multiple with them by connecting like terminals together.



Figure 10—No. 62A Selector Key

The principle of operation is the same for each of these selector keys for either the 17- or 27-step selector code. In the description of operation following, the numbers referring to the 27-step code are put in parenthesis following the numbers for the 17-step code.

The purpose of the push button keys is to set up the connections to the segments on the commutator so that as the brush revolves, the No. 26A Relay in the No. 60B Selector Apparatus Case will be operated so as to transmit to the line the correct sequence of impulses for operating the selector corresponding to the number called. The push button keys in the first group (red) correspond to the first number in the selector code and the keys in the second group (white) correspond to the third or last number in the selector code. To make a call, it will be necessary to operate one key in each of the first two groups. On the operation of the key in the second group a common contact S' (Figure 2) on the key unit is made momentarily and completes the circuit for the No. R-1027 Relay, and this relay on operating locks itself in. The No. R-1027 Relay completes connections for the No. 2F Lamp, No. 221JB Relay and the Telechron motor. Then as the brush passes over the segments, the No. 26A Relay is operated to give the sequence of impulses required.

It will be noted that with no keys operated in the first two groups, alternate segments from 0 to 28 (38) are connected to the K-2 terminal leading to the No. 26A Relay. In order to make a call, for example 8-5-4 (8-15-4), key 8 (red) should be operated in

the first group and key 4 (white) in the second group, assuming that key A in the third group was already operated. Then as the brush revolves, the No. 26A Relay will be operated alternately so as to send eight impulses as the brush passes the segments from 0 to 7 and will then remain not operated from segments 7 to 13, thus allowing the selectors to release or to be held by a code pin in the code wheel. Then, as the brush passes over segments 14 to 18 (14-28) the No. 26A Relay will be operated alternately so as to send five (15) impulses and be held in an operated position as the brush passes over segments 18 to 24 (28-34) again allowing the selectors to release or to be held by a code pin in the code wheel. Then as the brush passes over segments 25 to 28 (35-38) the No. 26A Relay will be operated alternately so as to send four impulses and advance the selector to its ringing position. The bell will ring until the brush leaves segment 48 (54) when the No. 26A Relay will be released and send out the restoring impulse. Then as the brush passes over segment 59 (62), the No. R-332 Relay is operated, which in turn releases the No. R-1027 Relay to stop the motor, to put out the lamp, and to release the No. 221JB Relay. The lamp indicates that the key is operating and another call should not be made while the lamp is lighted.

All selectors may be advanced to their time receiving position by operating key 1 (red) in the first group and key 1 (white) in the second group to transmit 22 (32) consecutive impulses. All selectors may be operated for a master call by operating key 0



Figure 11—No. 63B Selector Key

(red) in the first group and key 0 (white) in the second group to transmit 17 (27) consecutive impulses. The selectors may also be operated in various groups by operating corresponding keys in the first and second groups.

To call a No. 60BP Selector, the A, B, C or D Key (black) in the third group should also be operated, depending upon which of the four contacts of the selector it is to be operated to.

Of the three black non-locking keys in the third group, the R key is for operating the reversing (No. 26A) Relay, the L key for operating the line (No. 221JB) Relay and the S key for making a repeat call without changing the keys in the first and second groups. Also, if the operator desires to continue the time of the ringing of the bell at a station it can be done by holding the L and R keys operated when the answer back is first heard in the receiver. To stop the answer back, release the R key slightly before the L key. If after a call is started and it is wished to break it up, it may be done by operating key R which will hold the No. 26A Relay operated and prevent the impulses from being transitted to the line.

In each case the last keys operated will show the last call made.

TEST REQUIREMENTS FOR THE NOS. 62 AND 63 TYPE SELEC- TOR KEYS—(See Figure 45— Page 86)

In order to insure the correct tension of the contact spring (G) against the segments, the inside edges of the open ends of the contact spring should be set to mea-

sure $\frac{3}{16}$ inch before being assembled to the contact arm (F).

The terminal plate (B) and contact spring (G) should be adjusted so that the end of the contact spring will make positive contact in a radial line with the center portion of the overlapping ends of the segments. In no case should either edge of the contact spring be less than 0.015 inch from the ends of the segments. The terminal plate and contact spring mounting screws should be loosened sufficiently to shift the terminal plate and contact spring to make this adjustment.

The gear (I) and pinion (L) should be lined up to run freely. To reset gear and pinion, release the motor mounting screws and move the motor with its associated pinion to obtain sufficient clearance between the teeth of the pinion and the teeth of the gear.

The bearing of the gear (I) and the surfaces of the teeth of both gear and pinion should be lubricated with No. 3 Spindle Oil or it equivalent at least once in three months.

The segments should be cleaned approximately every three months by means of a small lettering brush saturated with carbon tetrachloride to dissolve all traces of foreign matter.

With 110 volts ± 10 volts A.C. 60 cycles connected directly to the B1 and B2 terminals for the Nos. 62A and B Selector Keys and with 110 volts ± 10 volts A.C. 60 cycles connected through a No. 335B Transformer for the Nos. 63A and B Selector Keys, and with the motor operating continuously by holding the No.

R-1027 Relay (Q) operated, the brush of each selector key shall make one complete revolution in $10 \pm \frac{1}{2}$ seconds.

The Nos. 542 and 543 Type Keys (X and Y) used on the Nos. 62 and 63 Type Selector Keys are made up of two and three key units respectively mounted on a faceplate. Each key unit contains a key slide. The slides are interlocked by a pin so that upon pressing any key to the lock position it shall release the plunger of any previously locked key in either key unit. Should a key previously depressed fail to release upon pressing a second key in that particular group, the following procedure should be taken. Remove the No. 542 or No. 543 Type Key giving the trouble from the selector key frame and loosen the hexagon nuts which mount the individual key units to the faceplate. Adjust the key units so that all the plunger rods are free in their respective clearance holes in the faceplate, taking care to keep the rows of keys in as nearly a parallel plane as possible so that the pin which interlocks the slides will not bind when the hexagon nuts are tightened.

Care should be taken when adjusting the key units to insure that the common contact S1 at the end of the Nos. 542B and 543B Keys (Y) will have a clearance of not less than 0.012 inch, or more than 0.025 inch between the contact springs when in the unoperated position.

The resistance of the No. R-1027 Relay (Q) is 95 ohms and it should receive from 0.080 to 0.120 ampere of current when operating under normal condi-

tions. For test purposes the relay should operate on a current of 0.040 ampere after the following adjustments are made: The armature travel should be 0.015 inch. The contact springs should have a tension of minimum 20 grams against their respective stops when in the unoperated position.

The resistance of the No. R-332 Relay (R) is 375 ohms and it should receive from 0.021 to 0.032 ampere current when operating under normal conditions. For testing purposes the relay should operate on a current of 0.015 ampere after the following adjustments are made: The armature travel should be 0.015 inch. The contact springs should have a tension of minimum 20 grams against their respective stops when in the unoperated position.

WAY STATION SELECTOR EQUIPMENT

NO. 160C AND NO. 160R SELECTOR SETS

The No. 160C Selector Set replaces the No. 160AC and the No. 160BC Selector Sets, and the No. 160R Selector Set replaces the No. 160AR and No. 160BR Selector Sets formerly furnished. The No. 160C Selector Set is for use on standard circuits where condensers are required in series with the No. 60AP or No. 60BP Selectors. The No. 160R Selector Set is for use in a repeating coil circuit where no condenser is required in series with the selector, and is the same as the No. 160C Selector Set except that the No. 138B Condenser is omitted.

The selector sets equipped with

a selector, contain all the receiving apparatus at the way station (see Figure 12) except the telephone set. They are metal cabinets approximately 13 inches high by 7 inches wide by 5½ inches deep, arranged for wall mounting.

The sets are arranged to hold the selector and are completely wired and provided with terminals for connecting the line and local battery wires as shown in

Figure 13 for the No. 160C Selector Set when equipped with a No. 60AP Selector and as shown in Figure 14 when equipped with a No. 60BP Selector. The connections for the No. 160R Selector Set are the same except that the No. 138B Condenser is omitted and the two wires to this condenser are connected together. The No. 160C and No. 160R Selector Sets do not include the



Figure 12—No. 160C Selector Set including No. 60AP Selector

No. 60AP or No. 60BP Selector as part of the equipment; the selector desired must be ordered separately.

The following is a short description of the apparatus in the No. 160C and No. 160R Selector Sets:

No. 60CG Ringer

The function of the ringer is to signal the way station operator and also to give the time signals. This ringer is a vibrating, direct current ringer, operating from the transmitter battery, and is provided with contact springs for opening its own circuit intermittently.

When a selector is operated to its ringing position, a local circuit through the local battery and the bell is completed and the bell

should ring for approximately 2 seconds, until the selector is released from the ringing position. The bell circuit may be tested by making a connection between terminals 1 and 2 on the selector.

While the bell is ringing, an answer-back or tone should be heard in the telephone receiver. This answer-back circuit is from the L1 line terminal; through the No. 141H Condenser to terminal 3 (Figure 13) or 6 (Figure 14), the holding spring, the code pin and code wheel to terminal of the selector when in the ringing position; through the local battery; through the intermittent contact on the ringer made between the right-hand contact spring and the contact on the center stop-piece; and through the No. 141H Condenser to Line 2.

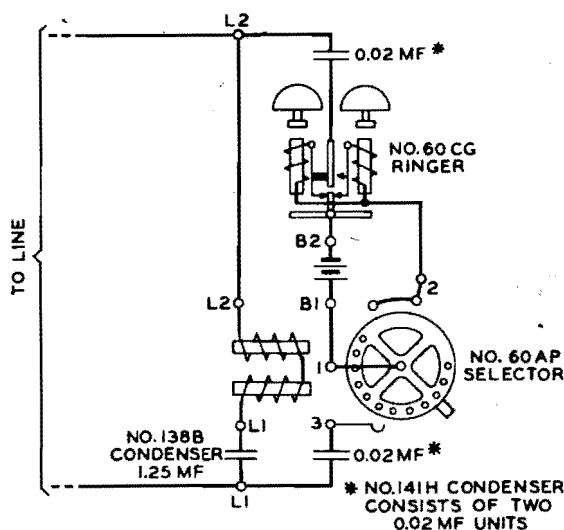


Figure 13—Schematic Circuit of the No. 160C Selector Set Equipped with a No. 60AP Selector

No. 60AP Selector (Not included with sets)

The function of the selector is to provide a quick and reliable means to call selectively one of a large number of way stations on the same telephone line without producing a signal at the other stations.

The D.C. resistance of the selector is 21,000 ohms. The selector may be operated in series with a $1\frac{1}{4}$ or $1\frac{1}{2}$ mf condenser or without a condenser through a No. 341A Transformer or a No. 70A Repeating Coil. The impedance of the selector and condenser at the operating frequency of $3\frac{1}{2}$ cycles is approximately 35,000 ohms. The impedance of the selector at talking frequency (800 cycles per second) is approximately 2 megohms.

Thus the loss in telephone transmission due to the selector bridge on the line is negligible.

The No. 60AP Selector (Figure 15) is of the step-by-step type and is operated by a definite code or sequence of alternating or reverse current impulses. It consists of a selecting unit mounted on a magnet unit with a bakelite base and a glass cover.

The code wheels are set so that the same total number of steps is necessary to advance the code wheel to the ringing position on all selectors that are to be used on the same line. With the number of holes provided in the code wheel this number of total steps may be any number from 8 to 32, which number would give a total of 6 to 378 code settings, respectively. The No. 60AP

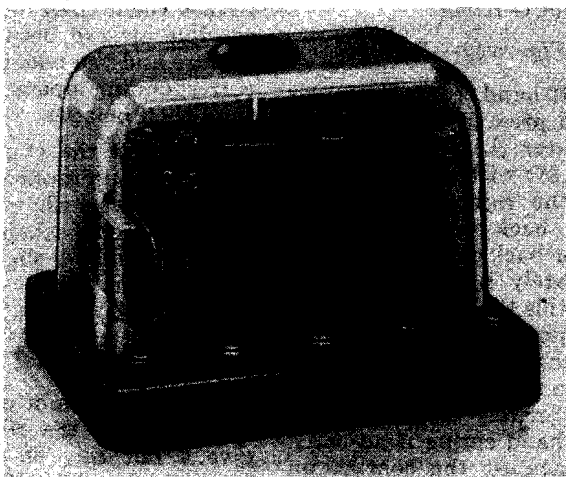


Figure 15—No. 60AP Selector

Selector is normally set for a total of 17 steps, which number gives a total of 78 code settings (see Table I, page 33). When selecting a station the selector is not stepped up by 17 consecutive impulses, but by three sets of successive impulses totalling 17 in number as indicated in Table I. (This number of impulses—17—does not count the restoring impulse.)

The code pins on each selector are located so that after the first set of impulses, the code wheel will be in position for the holding spring to engage with the first code pin. The second code pin is located so that after the second set of impulses, the code wheel will be in position for the holding spring to engage with the second code pin. The third set of impulses then advances the code wheel, so that the permanent code pin is in position to engage with the holding spring and, at the same time, the contact spring is directly over, and makes contact with, the first ringing terminal, thus completing the bell circuit. Each selector is capable of being set for any station number given in the Table I without any other change than the location of the two code pins in the code wheel.

The cycle of events in calling a station with the selector set for 8-5-4, for example, is as follows:

(Refer to Figures 1 and 13.) On operation of the calling key set for 8-5-4, the No. 221JB Relay operates and connects the sending equipment to the line. This relay remains operated during the complete operation of the key. The first set of impulses from the calling key operates the No. 26A

Relay so as to give eight reverse impulses on the line. These eight impulses advance all the selectors eight steps. Then, although the battery is held on the line for approximately one second, the condenser in series with each selector bridge stops the flow of current and the armatures of all selectors return to normal position. The code wheels on all selectors then return to normal position, except those that have a code pin on the code wheel in position for the holding spring to engage them. All selectors are then advanced by the second set of reverse impulses, 5 in this case.

Of the selectors that were held in an advanced position before, only the one called will now have a code pin in position to be engaged by the holding spring. Also, the selectors that returned to normal before, and have a code pin five steps from the normal position, will be in position to be held up by the holding spring. All other selectors will return to normal position during the second long period of approximately one second. The third set of reverse impulses, 4 in this case, advances all selectors four steps. Only the selector that had its code pins in the code wheel set for 8-5-4 (the selector called) will have been advanced to its ringing position—that is, a total of 17 steps from the normal position.

In the ringing position the contact spring on the top of the code wheel will be directly over the first ringing terminal and make contact with it. Some of the other selectors may be held up on the first or second code pins, but will not have been advanced

to the third or ringing code pin. During the ringing period of approximately two seconds, an answer-back or tone is heard by the dispatcher or any other receiver bridged across the line while the bell is ringing. After the ringing period, one impulse is transmitted to the line by the calling key as before, and all selectors are advanced one step and then return to the normal position. A similar sequence is followed in the operation of a selector with a different code setting.

In order to take care of cases where a greater number of code settings are required than those given in Table I, the code settings for a No. 60AP Selector set for 27 total steps in each code are given in Table II, which gives a total of 241 code settings.

The method of changing the code of a selector set for a 17-step code to a 27-step code is given under "Code Wheel," page 36.

No. 60BP Selector (Not included with sets)

The No. 60BP Selector (Figures 14 and 16) is known as the multiple contact selector and differs from the No. 60AP Selector in that it is equipped with four selective ringing terminals instead of one, so that any one of four local signal circuits can be closed by the same selector independently. This selector is not equipped with a terminal for receiving time signals.

The method of setting the code numbers and the method of operation is the same as described in detail for the No. 60AP Selector.

The terminals on the No. 60BP Selector are known by the letters A, B, C, and D. Terminal A is the first terminal engaged by the contact spring on the code wheel as the code wheel is advanced. The last group of impulses in the code setting for selecting the first or A contact is increased by two impulses to select the B contact, four impulses to select the C contact and six impulses to select the D contact. The numbers marked on the code card on the selector indicate the code setting for the A contact. For example, a selector having a code setting 8-5-4 for the first contact will be marked 8-5-4, and the contacts will be known as 8-5-4 A, 8-5-4 B, 8-5-4 C, 8-5-4 D.

The impulses required to select the four contacts on a No. 60BP Selector with code setting 8-5-4 will be 8-5-4 for the A contact, 8-5-6 for the B contact, 8-5-8 for the C contact, and 8-5-10 for the D contact.

In Tables I and II all the code settings are marked with a star which can be used for the No. 60BP Selector without interference when No. 60AP Selectors are also connected to the same line. Additional code settings that may be used when only No. 60BP Selectors are used on a system are marked with a dot.

The No. 60BP Selector functions in all other respects in the same way as the No. 60AP Selector.

Figure 14 shows the wiring connections for the No. 60BP Selector in the No. 160C Selector Set and the method of connecting the extension bells.

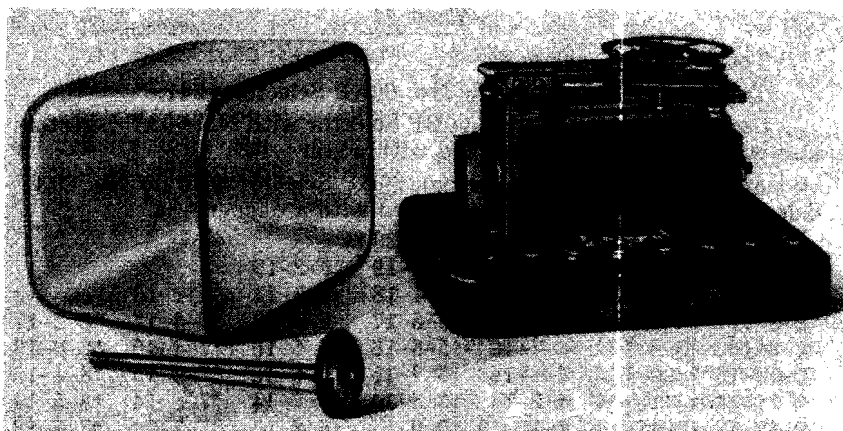


Figure 16—No. 60BP Selector

CODE SETTINGS FOR SELECTORS

Table I

Total steps in each code—17.

Total code settings for the No. 60AP Selector—78.

Code settings for the No. 60BP Selector with No. 60AP Selectors also on the same line are marked with a star—28.

Additional code settings for the No. 60BP Selector with no No. 60AP Selectors on the same line are marked with a dagger—18.

2-2-13									
2-3-12	3-2-12								
2-4-11	3-3-11	4-2-11							
2-5-10	†3-4-10	4-3-10	†5-2-10						
2-6-9	†3-5-9	4-4-9	†5-3-9	6-2-9					
2-7-8	†3-6-8	4-5-8	†5-4-8	6-3-8	*7-2-8				
2-8-7	†3-7-7	4-6-7	†5-5-7	6-4-7	*7-3-7	*8-2-7			
2-9-6	†3-8-6	4-7-6	†5-6-6	6-5-6	*7-4-6	*8-3-6	*9-2-6		
2-10-5	†3-9-5	4-8-5	†5-7-5	6-6-5	*7-5-5	*8-4-5	*9-3-5		
2-11-4	†3-10-4	4-9-4	†5-8-4	6-7-4	*7-6-4	*8-5-4	*9-4-4		
2-12-3	†3-11-3	4-10-3	†5-9-3	6-8-3	*7-7-3	*8-6-3	*9-5-3		
2-13-2	†3-12-2	4-11-2	†5-10-2	6-9-2	*7-8-2	*8-7-2	*9-6-2		
*10-2-5									
*10-3-4		*11-2-4							
*10-4-3		*11-3-3		*12-2-3					
*10-5-2		*11-4-2		*12-3-2		*13-2-2			

Table II

Total steps in each code—27.

Total code settings for the No. 60AP Selector—241.

Code settings for the No. 60BP Selector with No. 60AP Selectors also on the same line are marked with a star—147.

Additional settings for the No. 60BP Selector with no No. 60AP Selectors on the same line are marked with a dagger—38.

2-5-20	†3-4-20	4-3-20	†5-2-20			
2-6-19	†3-5-19	4-4-19	†5-3-19	6-2-19		
2-7-18	†3-6-18	4-5-18	†5-4-18	6-3-18	*7-2-18	
2-8-17	†3-7-17	4-6-17	†5-5-17	6-4-17	*7-3-17	*8-2-17
2-9-16	†3-8-16	4-7-16	†5-6-16	6-5-16	*7-4-16	*8-3-16
2-10-15	†3-9-15	4-8-15	†5-7-15	6-6-15	*7-5-15	*8-4-15
2-11-14	†3-10-14	4-9-14	†5-8-14	6-7-14	*7-6-14	*8-5-14
2-12-13	†3-11-13	4-10-13	†5-9-13	6-8-13	*7-7-13	*8-6-13
2-13-12	†3-12-12	4-11-12	†5-10-12	6-9-12	*7-8-12	*8-7-12
2-14-11	†3-13-11	4-12-11	†5-11-11	6-10-11	*7-9-11	*8-8-11
2-15-10	†3-14-10	4-13-10	†5-12-10	6-11-10	*7-10-10	*8-9-10
2-16-9	†3-15-9	4-14-9	†5-13-9	6-12-9	*7-11-9	*8-10-9
2-17-8	†3-16-8	4-15-8	†5-14-8	6-13-8	*7-12-8	*8-11-8
2-18-7	†3-17-7	4-16-7	†5-15-7	6-14-7	*7-13-7	*8-12-7
2-19-6	†3-18-6	4-17-6	†5-16-6	6-15-6	*7-14-6	*8-13-6
2-20-5	†3-19-5	4-18-5	†5-17-5	6-16-5	*7-15-5	*8-14-5
2-21-4	†3-20-4	4-19-4	†5-18-4	6-17-4	*7-16-4	*8-15-4
2-22-3	†3-21-3	4-20-3	†5-19-3	6-18-3	*7-17-3	*8-16-3
2-23-2	†3-22-2	4-21-2	†5-20-2	6-19-2	*7-18-2	*8-17-2
*9-2-16						
*9-3-15	*10-2-15					
*9-4-14	*10-3-14	*11-2-14				
*9-5-13	*10-4-13	*11-3-13	*12-2-13			
*9-6-12	*10-5-12	*11-4-12	*12-3-12	*13-2-12		
*9-7-11	*10-6-11	*11-5-11	*12-4-11	*13-3-11	*14-2-11	
*9-8-10	*10-7-10	*11-6-10	*12-5-10	*13-4-10	*14-3-10	*15-2-10
*9-9-9	*10-8-9	*11-7-9	*12-6-9	*13-5-9	*14-4-9	*15-3-9
*9-10-8	*10-9-8	*11-8-8	*12-7-8	*13-6-8	*14-5-8	*15-4-8
*9-11-7	*10-10-7	*11-9-7	*12-8-7	*13-7-7	*14-6-7	*15-5-7
*9-12-6	*10-11-6	*11-10-6	*12-9-6	*13-8-6	*14-7-6	*15-6-6
*9-13-5	*10-12-5	*11-11-5	*12-10-5	*13-9-5	*14-8-5	*15-7-5
*9-14-4	*10-13-4	*11-12-4	*12-11-4	*13-10-4	*14-9-4	*15-8-4
*9-15-3	*10-14-3	*11-13-3	*12-12-3	*13-11-3	*14-10-3	*15-9-3
*9-16-2	*10-15-2	*11-14-2	*12-13-2	*13-12-2	*14-11-2	*15-10-2
*16-2-9						
*16-3-8	*17-2-8					
*16-4-7	*17-3-7	*18-2-7				
*16-5-6	*17-4-6	*18-3-6	*19-2-6			
*16-6-5	*17-5-5	*18-4-5	*19-3-5	*20-2-5		
*16-7-4	*17-6-4	*18-5-4	*19-4-4	*20-3-4		
*16-8-3	*17-7-3	*18-6-3	*19-5-3	*20-4-3		
*16-9-2	*17-8-2	*18-7-2	*19-6-2	*20-5-2		

**TEST REQUIREMENTS FOR NO. 60
TYPE SELECTORS (See Figure
39—Page 74)**

As an aid in testing or checking at definite intervals, the main mechanical adjustments and electrical tests are outlined below for the No. 60 Type Selectors:

MECHANICAL REQUIREMENTS:

Stepping Pawl

The stepping pawl (V), when in normal position should clear all teeth of the ratchet wheel (X), when revolved by hand, by not less than 0.005 inch.

The guide post may be bent slightly for this adjustment.

The stepping pawl (V) in normal position should rest against its guide post, it may be changed by tensioning the retractile spring (W). Care should be taken however that this tension is not too great.

The total travel of the stepping pawl (V) should be not less than $1\frac{3}{4}$ nor more than 2 teeth.

Holding Pawl

The tail of the holding pawl (R) where it touches the rocker arm stud should be bent so that the holding pawl clears the teeth of the ratchet wheel (X), when revolved by hand, by not less than 0.005 inch.

The ratchet wheel cam should be adjusted so that the ratchet wheel (X) is in position for the holding pawl (R) to fall reliably in the first tooth (before the ratchet wheel is advanced) with a maximum backlash of 0.005 inch.

The retractile spring (S) on the holding pawl (R) should be adjusted by bending its bracket to give sufficient tension to insure that the holding pawl will press against the face of each tooth as the ratchet wheel (X) is advanced. Care should be taken that this tension is not unnecessarily great.

Holding Spring

When the code wheel (E) is revolved by hand the cup-shaped part of the holding spring (K) should clear the inside of the code pins (C) by not less than 0.005 inch and shall clear the shoulder part of the code pins by not less than 0.015 inch. This adjustment is made by bending the section of the spring between the cup-shaped part and where it rests against the rubber roller on the rocker arm (T).

The holding spring (K) should be adjusted by shifting it along the longitudinal holes after loosening the clamping screws (I), so that it shall clear the code pins (C) in its outward motion by not less than 0.005 inch.

After a given number of steps of the code wheel (E), according to the setting of the code pins (C), the holding spring (K) should on the release of the armature (P) engage with the code pins and retain the code wheel in that position until advanced by another step.

The holding spring (K) should be adjusted by bending it near the clamping plate (H) until it has sufficient tension to insure that in normal position it will just touch the rubber stud on the rocker arm (T).

The slotted end of the No. 145 Tool should be used for adjusting this spring.

Code Wheel

The code wheel (E) should be adjusted on its shaft so that after 17 steps for the 17 step code or 27 steps for the 27 step code the contact spring will make contact with the first ringing terminal and the permanent code pin will be in position to be engaged by the holding spring (K). The code wheel (E) should be set near the top of the shaft so that its holding screws (F) will clear the spring washer under the ratchet cam screw.

To change the setting from the 17 to the 27 step code, loosen slightly the two screws holding the code wheel (E) on the shaft, then step the ratchet wheel (X) up 27 steps and hold it, then slip the code wheel on the shaft so that the contact spring will make contact with the first ringing terminal and the permanent code pin will be in position to be engaged by the holding spring. Tighten firmly the screws holding the code wheel on shaft.

Conical Head Stop Screw

The adjusting screw (N) should be adjusted so that as the armature (P) operates, the stepping pawl (V) will advance the ratchet wheel (X) sufficiently to allow the holding pawl (R) to fall in the next tooth reliably.

The wrench on the end of the No. 115 Tool should be used for loosening the lock nut of this screw, and a small screw-driver for turning the screw. The lock nut (O) should be tightened after

each adjustment to prevent any further change.

Contact Spring

The contact spring should, in normal position, be adjusted so that it just touches the code wheel (E). The slotted end of the No. 145 Tool should be used for this adjustment.

The contact spring should be raised by the ringing terminals when in the ringing position by not less than 0.020 of an inch. If necessary, bend the terminal end of spring slightly.

The short section of the spring into which the contact is fitted should be parallel with the code wheel.

The contact spring when one step before or beyond the ringing terminals should not make contact with them. In bending the ringing terminals for this adjustment, care should be taken not to loosen the terminal rivets.

Spiral Spring

The spiral spring (AB) should have sufficient tension to restore the code wheel (E) to normal position both when the code wheel is released slowly by hand as the contact spring passes over the ringing terminals, and also when the code wheel is in any position where it is not held by the holding spring (K) engaging with a code pin (C).

The button hook on the No. 145 Tool should be used for adjusting the spiral spring by moving the supporting arm of the outer end of the spring clockwise to increase the tension or counter clockwise to decrease the tension.

Rocker Arm Retractable Spring

The retractile spring (U) on the rocker arm (T) should be adjusted by bending its bracket so that its tension will be sufficient to restore the rocket arm reliably to normal position at all times when no current is flowing through the selector.

The tension of this spring should not be unnecessarily great as it will then require a higher voltage for operating the selector.

Method of Setting Code

The code pins in the code wheel of each selector should be located so that after a number of steps corresponding to the first number of the code, the code wheel will be in position for the holding spring to engage with the first code pin.

The second code pin shall be located so that after a number of steps corresponding to the second number of the code, the code wheel will be in position for the holding spring to engage with the second code pin.

The third number of steps corresponding to the third number of the code shall then advance the code wheel, so the permanent code pin shall be in position to engage with the holding spring and at the same time the contact spring shall be directly over and shall make contact with the first ringing terminal.

The No. 144 and No. 145 Tools should be used for setting the code pins.

Apply sparingly Eagle No. 3 Spindle Oil or its equivalent to the selector parts as listed below

only after these specified parts have been thoroughly cleaned with a small lettering brush carrying enough carbon-tetrachloride to dissolve any remaining oil or other matter:

The surfaces of the rocker arm (T) which come in contact with the phosphor bronze pins.

The side of the rounded end of the holding pawl (R) which comes into contact with the stud.

The engaging tips of the pawls (R and V).

The teeth of the ratchet wheel (X).

The bearings of the armature (P), pawls (R and V), rocker arm (T) and the ratchet wheel shaft (X).

To apply oil sparingly, insert the fine end of a toothpick into the oil reservoir and then allow the amount of oil picked up by the end of the toothpick to drain off to the part to be lubricated.

ELECTRICAL REQUIREMENTS

No. 60B Test Set

The No. 60B Test Set (Figures 17 and 18) is a small portable set suitable for testing selectors or selector sets for their electrical operation.

The set consists of a relay for reversing the current through the selector, a potentiometer for varying the current through the selector, three small keys to give test conditions, a meter and a condenser, all mounted on a removable panel in a black finished sheet steel box $8\frac{1}{8}$ inches long, $7\frac{1}{4}$ inches wide and $5\frac{3}{4}$ inches

deep. The box is equipped with a carrying handle.

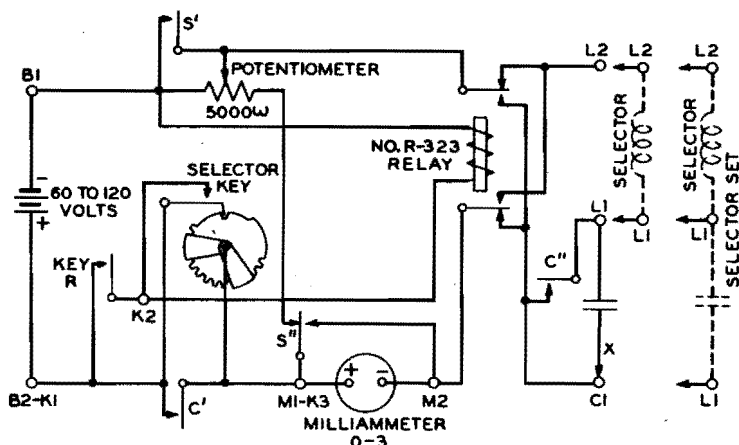
The panel is arranged to mount a No. 60 Type Selector Key for operating the selector under test and there is space in the bottom of the box for mounting three No. 768 Eveready Batteries to be connected in series and to the B1

and B2 terminals. The complete set including batteries weighs 14 pounds.

The resistance of the No. R-323 Relay is 3600 ohms and it should receive from 0.013 to 0.033 ampere of current when operating under normal conditions. For test purposes the relay should



Figure 17—No. 60B Test Set



NOTE:— KEY S CONSISTS OF S' AND S"
KEY C CONSISTS OF C' AND C''

Figure 18—Schematic Circuit of the No. 60B Test Set

operate on a current of 0.0085 ampere after the following adjustments are made:

The armature travel should be 0.020 inch.

The contact springs should have a tension of minimum of 20 grams against their respective stops when in the unoperated position. There should be an air-gap of 0.005 inch between contacts.

A No. 60A or 60B Selector Key set to the same code as the selector to be tested and adjusted for its mechanical and electrical requirements as outlined on pages 14 to 17, should be mounted in the panel; or a No. 61A or No. 61B Selector Key may be connected to the K1, K2 and K3 terminals of the test set; or a No. 62A or No. 62B Selector Key may be used by connecting ter-

minals K1, K2, K3 of the test set to terminals B4, K2, K3 of the selector key. In the latter case the selector key will require either 12 or 24 volts connected to terminals B3 and B4.

Instead of using three No. 768 Eveready Batteries in the set, an external battery of 60 to 120 volts may be connected to the B1 and B2 terminals.

Selector Operate and Release Tests

The selector to be tested should first be adjusted to meet its mechanical requirements; then connect the L1 and L2 terminals of the selector to like terminals in the No. 60B Test Set as shown in Figure 18.

With key C operated adjust the potentiometer so that the current through the selector as indicated by the meter will be

2.4 milliamperes. Then on operating the selector key, the selector should operate as described on page 31. While the selector key is operating the relay should give a series of impulses corresponding to the selector code and advance the selector code wheel so that the contact spring makes contact with the ringing terminal. Then after approximately two seconds, the clearing-out impulse should release the selector and allow it to return to the normal position. If the selector fails to operate check the mechanical requirements and determine what change may be made so that the selector will meet this operate test.

With key C operated, adjust the potentiometer so that the current through the selector as indicated by the meter will be 0.15 milliamperes. Then with both key C and key S operated the selector armature will be attracted to one side and as key S is released, the armature of the selector should release within one second. With key R, key C and key S operated the selector armature will be attracted to the other side and as key S is released, the armature of the selector should release within one second.

If the armature fails to release from both sides as key S is released in both cases described, increase the tension of the retractile spring on the rocker arm.

If the armature fails to release from one side only as key S is released, the core on that side should be adjusted so that the air-gap is sufficient to allow the armature to release. To adjust the air-gap, loosen the lock-nut on the opposite end of the core

and turn the core with a screwdriver in a clockwise direction to decrease the air-gap, and in a counter-clockwise direction to increase the air-gap. The lock-nut on the core should be tightened before making the release test because if tightened afterwards, the air-gap may be changed. The air-gap between the armature and core when operated should not be greater than 0.005 inch.

The selectors should be adjusted to meet the operate and release tests with the same adjustment for both tests. In order to get this condition, it may be necessary to go over the mechanical adjustments to see if they have not been made severer than necessary.

Test Requirements for No. 160 Type Selector Sets

To test a selector set without a condenser in series with the selector, connect the L1 and L2 terminals of the selector set to the L1 and L2 terminals of the test set.

To test a selector set with a condenser in series with the selector in the selector set, connect the L2 and L1 terminals of the selector set to the L2 and C1 terminals of the test set and L1 terminal of the selector to the L1 terminal of the test set and disconnect lead X from terminal C1 in the test set.

Then for either of the above conditions the same tests should be made for the selector set as given for the selector above. As the selector key set for the code of the selector in the selector set is operated, the selector should advance and ring the bell. If the bell fails to ring, first determine

if the selector functions properly; if so, the trouble is in the bell circuit, probably due to poor contacts, batteries exhausted or bell adjustment. By connecting terminals 1 and 2 on the selector the bell should ring. Refer to page 28 for bell adjustment and answer-back circuit.

If the selector fails to function properly, it may be due to the condenser in the selector set. By disconnecting the L1 lead from the selector set, and connecting lead X to terminal C1 in the test set, the condenser in the test set may be substituted for test for the condenser in the selector set.

No. 127-J Extension Bell

This bell consists of a No. 60CG ringer and a condenser mounted in an oak box and is used as an extension signal in connection with the No. 60BP Selector. The No. 60CG Ringer in the No. 160C or 160R Selector Set in which the No. 60BP Selector is mounted gives the signal for the first or A ringing terminal. One of these extension bells is required for each signal desired in addition to the one in the selector set.

These sets are arranged to be connected directly to the terminals in the No. 160C or 160R Selector Set as follows: Terminal L2 (Figure 14) of the extension bell to be connected to terminal L2 in the selector set. Terminal B2 of the extension bell to be connected to terminal B2 in the selector set. Terminal S of the extension bell to be connected to the terminal 3 or 4 or 5 on the base of the No. 60BP Selector as desired. These connections are shown on a circuit label furnished

with the selector sets and in Figure 14.

The No. 60CG Ringer has been described on Page 28.

NO. 60A TIME SENDING SET

In addition to the operation of selecting a station as described for the No. 60AP Selector, the selector is provided with a second or time ringing terminal for receiving time. For this purpose a time sending set (Figure 19) connected as shown in Figure 20 is used with the No. 60B Selector Apparatus Case for sending the time signals over selector circuits. The set consists of a No. 149AN and a No. R-1971 Relay, a switch, and four No. 63C Resistances mounted in a black finished steel case approximately $6\frac{5}{16}$ by $7\frac{5}{8}$ by $6\frac{1}{4}$ inches.

The normal operating position of the time switch is in the "call position." When it is desired to send time signals a selector key set to send 22 consecutive impulses for the 17-step code or 32 impulses for the 27-step code is operated. This steps all the code wheels of the No. 60AP Selectors on the circuit up to the time receiving position (code wheel contact within one step of closing the second or time contact) where it is retained by an insulated "time arm." The time switch is then operated to the "time position." This completes the circuit between terminals K1 and K3 and connects K2 to the lower contact of the No. R-1971 Relay. Closing circuit to terminals K1 and K3 operates the No. 221JB Relay which connects the main battery to the line. Then as a



Figure 19—No. 60A Time Sending Set

time-repeating relay in the telegraph circuit operates and completes the circuit between terminals T1 and T2, the No. R-1971 Relay will operate and on the opening of the T1-T2 circuit, the No. 149AN Relay will operate. On the second closure of the T1-T2 circuit, the No. R-1971 Relay

will release and on the second opening of the T1-T2 circuit the No. 149AN Relay will release.

Thus on the first closure of the T1-T2 circuit the No. 26A Relay in the selector apparatus case will be operated by the closure of the lower contact of the No. R-1971

Relay and send out a positive pulse on the line to advance all the No. 60AP Selectors one step. This momentarily closes the time contacts on all selectors and causes all bells to tap. The selectors on the line then fall back to a position within one step of closing the time contact and are held there as before by the "time arm" engaging with the holding spring.

Then as the time-repeating relay operates a second time to close the T1-T2 circuit the lower contact of the No. R-1971 Relay will be opened and release the No. 26A Relay to send out an impulse of the opposite polarity over the line, operating all the No. 60AP Selectors and causing all bells to tap as before. This series of operations is repeated for each two operations of the time-repeating relay, thus causing the bell to tap once each time

the time-repeating relay operates.

The No. 149AN Relay is sufficiently slow in releasing to prevent the time sending set from pulsing fast enough to cause the No. 60AP Selectors on the line to step off the "time arm" if the time sending set is connected to the time-repeating relay when telegraph impulses are being sent.

After the time signals have been sent, the time switch is operated to the selector call position. The selectors on the line are then stepped off the "time arm" by the sending of four impulses of the operation of any selector key. The circuit is then in condition for regular calling.

The time sending set functions on the local battery of either 12 or 24 volts. The "time arm" of the No. 60AP Selector is insulated from the bell circuit to open the

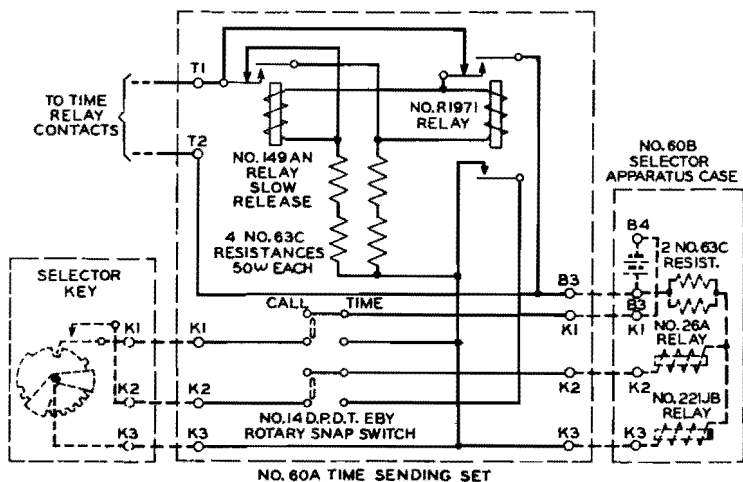


Figure 20—Schematic Circuit of No. 60A Time Sending Set

answer-back circuit and thus prevent the tone from interfering with telephone conversation while time signals are being sent.

Test Requirements for the Nos.

149AN and R-1971 Relays

The resistance of the No. 149AN Relay is 167 ohms and it should receive from 0.030 to 0.045 ampere of current when operating under normal conditions. For test purposes the relay should operate on a current of 0.018 ampere and should not operate on a current of 0.014 ampere.

The resistance of the No. R-1971 Relay is 100 ohms and it should receive from 0.040 to 0.060 ampere of current when operating under normal conditions. For test purposes the relay should operate on a current of 0.030 ampere after the following adjustments are made:

The armature travel should be 0.035 of an inch. The contact springs should have a tension of minimum 20 grams against their respective stops when in the un-operated position.

There should be an air-gap of minimum 0.005 inch between open contacts.

OPERATION OF SELECTOR CIRCUITS THROUGH A TRANSFORMER

In many cases, it is of advantage to operate train and message circuits equipped with No. 60 Type Selectors through a transformer in the dispatcher's station or at an intermediate station to:

- (1) Obtain a low resistance in the simplex telegraph leg.
- (2) Operate two or more simplex selector circuits from a common battery supply.
- (3) Operate one or more branch selector circuits from the main selector circuit without any metallic connection to it.
- (4) Allow two selector circuits to be used as side circuits for obtaining a composited or simplex phantom with the physical and phantom telephone and the telegraph circuits terminated at the same or different points.

NO. 341A TRANSFORMER

The No. 341A Transformer has been developed to replace the No. 70A Repeating Coil formerly used on train dispatching lines.

The No. 341A Transformer has a shell type silicon steel core clamped between angle iron brackets which also provide a mounting for the transformer and for the terminal connecting block. The transformer is approximately 5½ inches high by 6 inches wide and 5 inches deep, and weighs approximately 20 pounds. It has four windings brought out to separate terminals. The primary windings (1-2 and 5-6) each have a resistance of approximately 90 ohms and the two secondary windings (3-4 and 7-8) each have a resistance of approximately 170 ohms. The two primary windings and the two secondary windings are each balanced from a resistance, inductance and capacity standpoint to within 200 crosstalk units to permit the coil to be used on simplex telephone

circuits arranged for duplex telegraph without interference from the telegraph on the side or phantom telephone circuits.

The transformer is especially designed for repeating the low-frequency ($3\frac{1}{2}$ -cycle) selector impulses for long lines with a large number of selectors. The impedance at 1,000 cycles of the two secondary windings connected in series aiding is approximately 6,000 ohms, and of the two primary windings in series aiding is approximately 12,000 ohms. The loss in telephone transmission from bridging the transformer on a train dispatching line as a simplex bridge is, therefore, very small.

The loss in telephone transmission due to inserting a No. 341A Transformer between two 1,000,-

ohm impedance lines of No. 9 B. & S. gauge non-loaded open copper wire is approximately $3\frac{3}{4}$ db.

No. 70A REPEATING COIL

The No. 70A Repeating Coil is a toroidal-type coil mounted on a wood base. The complete coil is approximately $8\frac{1}{2}$ inches wide by 11 inches deep by 5 inches high, and weighs approximately 26 pounds.

The coil has four windings brought out to separate terminals. The two secondary windings (3-4 and 7-8) each have a resistance of approximately 40 ohms, and the two primary windings (1-2 and 5-6) each have a resistance of approximately 45 ohms. The primary windings and

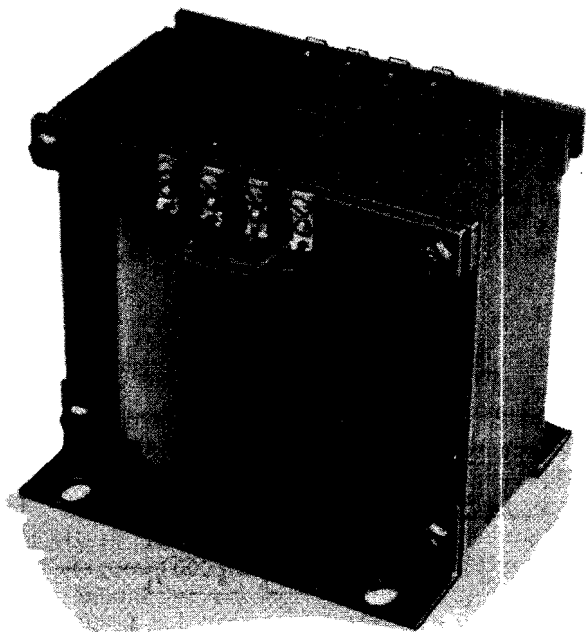


Figure 21—341A Transformer

2 10.

FIG.

210A.

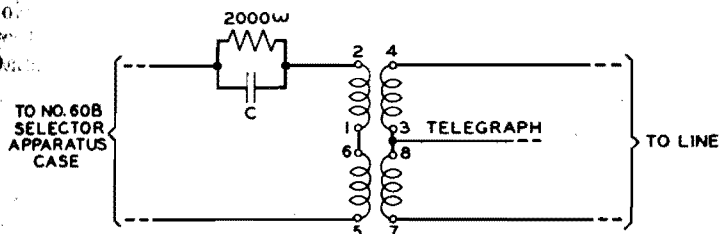


Figure 22—Selector Circuit Operated Through No. 341A Transformer

the secondary windings are balanced from a resistance, inductance, and capacity standpoint to within 200 cross-talk units to permit the coil to be used on simplex telephone circuits arranged for duplex telegraph without interference from the telegraph.

The No. 70A Repeating Coil was designed for repeating the low-frequency ($3\frac{1}{2}$ -cycle) selector impulses and for telephone transmission frequencies. The loss in telephone transmission due to inserting a No. 70A Repeating Coil between two 1,000-ohm impedance lines of No. 9 B. & S. gauge non-loaded open copper wire is approximately $\frac{3}{4}$ db. The impedance at 1,000 cycles of either the two primary or the

two secondary windings of the coil connected in series aiding is approximately 8,000 ohms. The loss in telephone transmission from bridging the coil on a train dispatching line as a simplex bridge is therefore small.

TRANSFORMER AT DISPATCHER'S STATION

When the entire selector circuit is to be operated through a transformer, the No. 341A Transformer should be used and the connections should be as shown in Figure 22. The telephone set should be connected to the line side of the transformer.

If it is desired to use the No. 70A Repeating Coil formerly used

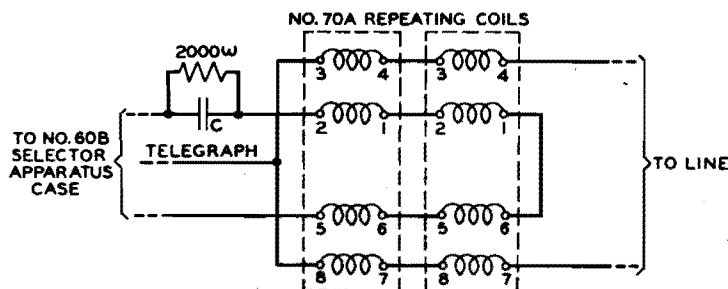


Figure 23—Selector Circuit Operated Through Two No. 70A Repeating Coils in Series Aiding

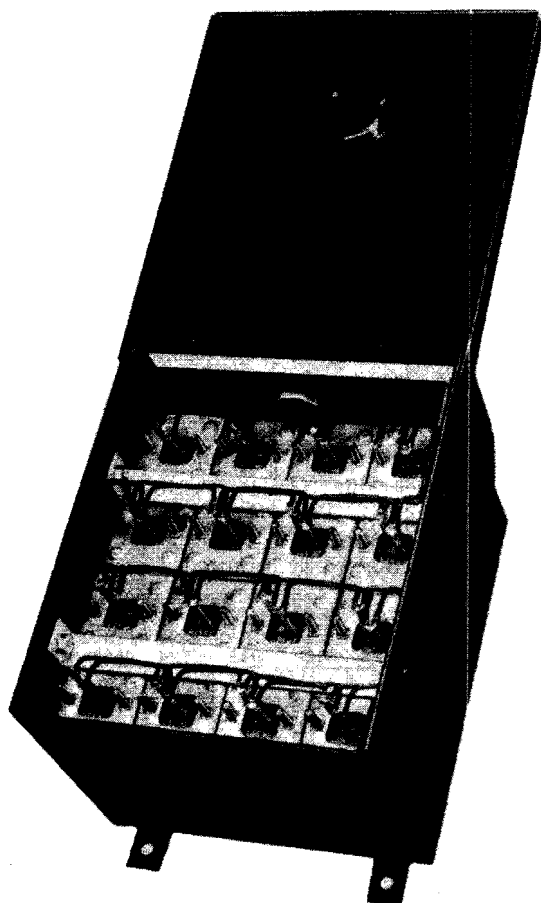


Figure 24—No. 160B Condenser

at the dispatcher's station, one or more coils as required should be connected as shown in Figures 22 or 23.

The capacity of the condenser shown at C (Figures 22 and 23) in each case should be not less than 10 mf plus 1 mf for each selector on the circuit. A resistance of 2,000 ohms (Ward-

Leonard EB-2000 or DM-2000) should be connected in parallel with the condensers to prevent oscillatory discharges of the condensers from interfering with the operation of the selectors.

A No. 160B Condenser has been especially designed for use for the condenser at C. The No.

160B Condenser (Figure 24) is a black metal box approximately 5 inches high, $6\frac{1}{4}$ inches wide and $7\frac{1}{2}$ inches deep, equipped with 16 No. 138B Condensers connected in parallel giving a normal capacity of 20 mf. As many of these condenser units connected in parallel should be used as are required to give the total capacity required at C.

When a No. 60B Rectifier is used as the line battery supply for a system operating through a transformer with the circuit connections shown (Figure 22) the No. 221JB Relay in the No. 60B Selector Apparatus Case should be strapped so as to bridge its normally open contacts. This allows the condensers in the rectifier set to become discharged at

the end of a call and thus prevent two preliminary pulses through the selectors on the next call.

The voltage of the main battery required is somewhat greater when operating through a transformer than given in Figure 3 for a direct ringing circuit. The curves (Figure 25) show the normal voltage required when using the No. 341A Transformer with different length lines of No. 9 B. & S. copper wires 8.3 ohms per loop mile and with selector sets uniformly distributed. Similarly, the curves (Figure 26) show the normal voltage required when using one No. 70A Repeating Coil and when using two or three No. 70A Repeating Coils connected in series aiding as required.

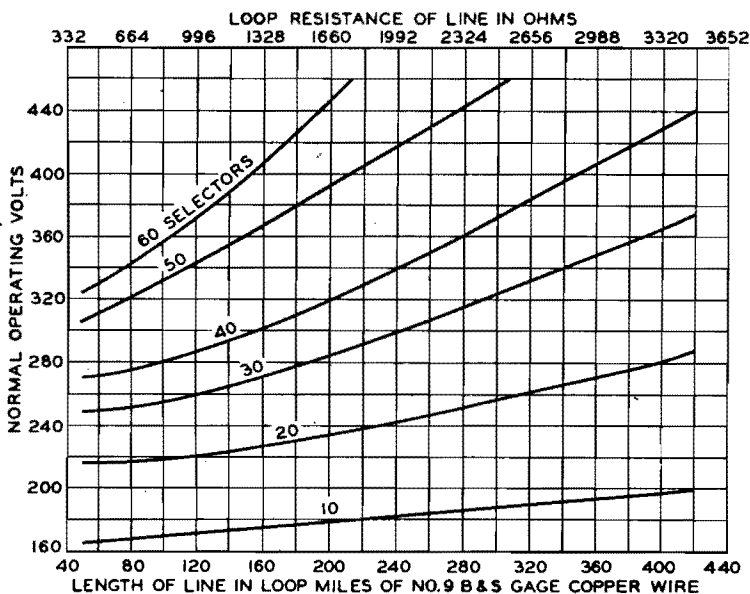


Figure 25—Curves for No. 160 Type Selector Sets Operated Through No. 341A Transformer

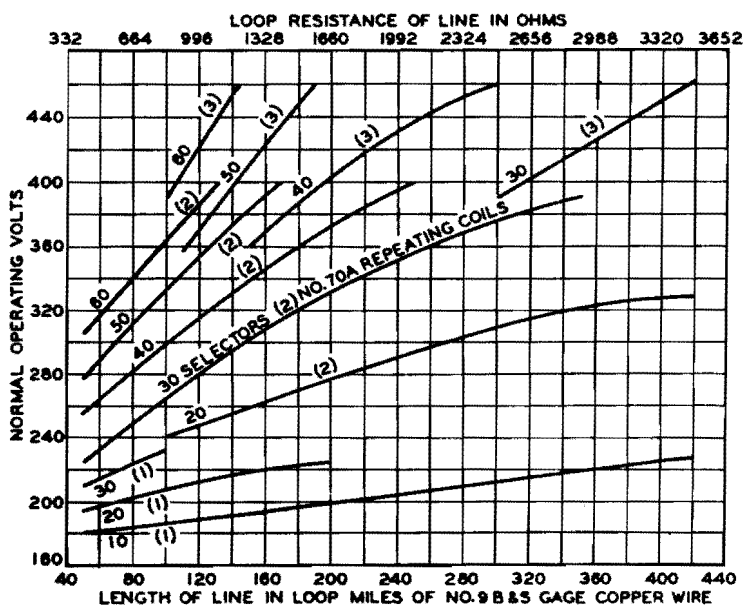


Figure 26—Curves for No. 160 Type Selector Sets Operated Through No. 70A Repeating Coils

It will be seen from Figures 25 and 26 that the No. 341A Transformer is considerably more efficient than the No. 70A Repeating Coil in repeating the selector impulses to the line. Even with a very long line only one No. 341A Transformer will be required while with the No. 70A Repeating Coil two or three coils will be required.

TELEGRAPH DROP AT INTER-MEDIATE STATION

When a simplex telegraph drop is required at an intermediate station either the No. 341A Transformer or the No. 70A

Repeating Coils as required may be connected in the line circuit as shown in Figure 27. In this case the main selector line at the dispatcher's station should be operated through a No. 341A Transformer as shown in Figure 22. As stated above, the No. 341A Transformer is more efficient for transmitting the selector impulses, while on the other hand there will be more telephone transmission loss than with one or two No. 70A Repeating Coils.

The telephone transmission loss may be reduced from approximately $3\frac{3}{4}$ db for the No. 341A Transformer (Figure 27) to ap-

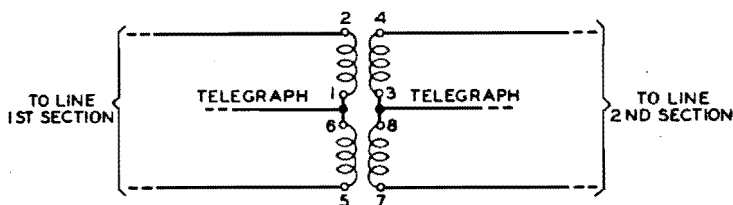


Figure 27—Intermediate Simplex Telegraph Drop

proximately $1\frac{1}{2}$ db by adding a No. 94E Repeating Coil and condensers connected as shown in Figure 28.

The No. 67C or 77A Repeating Coil should not be used in this case as they will become saturated by the high voltage on the line when calling a selector and increase the loudness of the thumps in the telephone receivers considerably.

If the telegraph drop does not terminate at the intermediate

station but is looped through telegraph equipment to the second section, the lines of the two sections may be connected by 2 mf or 4 mf condensers. That is, connect one set of condensers to terminals 2 and 4, and the other set to terminals 5 and 7 of the No. 341A Transformer. The telephone transmission loss will then be reduced to approximately 1 db when using 2 mf condensers for connecting each side of the line and to approximately $\frac{3}{4}$ db when using 4 mf condensers for connecting each side of the line.

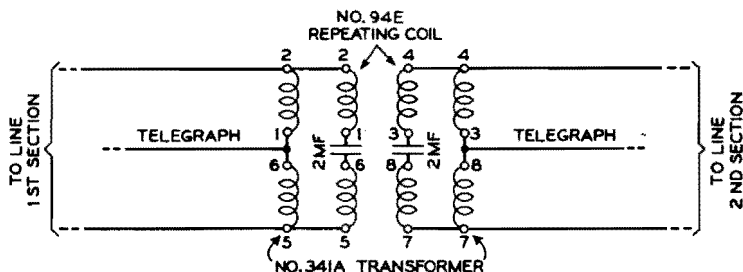


Figure 28—Intermediate Simplex Telegraph Drop with Voice Frequency By-Pass Repeating Coil

BRANCH LINE

When a branch circuit is required without any metallic connection to the main line, and the main line is not operated through a transformer at the dispatcher's station, it should be connected to the main line by a No. 341A Transformer or No. 70A Repeating Coils as shown in Figure 29. The capacity of the condenser at C should be not less than 10 mf plus 1 mf for each selector on the branch line.

When the main line is operated through a transformer at the dispatcher's station as shown in Figure 22 the primary of the No. 341A Transformer or the No. 70A Repeating Coils should be connected directly to the main line without any condensers or resistance in series. In these cases also the telephone transmission loss can be reduced by adding the No. 94E Repeating Coil and condensers connected in a manner similar to that shown in Figure 28.

SIMPLEX BRIDGE

For a simplex bridge at the far

end of a train or message line operated through a transformer at the dispatcher's station a No. 341A Transformer or a No. 70A Repeating Coil should be connected as shown at the far end of each side circuit in Figure 30.

When the selector circuit is not operated through a transformer at the dispatcher's station, No. 34C Resistances connected to give not less than 2,000 ohms should be connected between each side of a simplex coil and the line wires at the dispatcher's station, and No. 34C Resistances connected to give not less than 1,000 ohms should be connected between each side of a simplex coil and the line wires at the far end of the line.

COMPOSITED PHANTOM

A general arrangement for using train and message lines for side circuits of a composited phantom, to give two simplex telegraph circuits and a through telephone circuit in addition to the two selector circuits is shown in Figure 30.

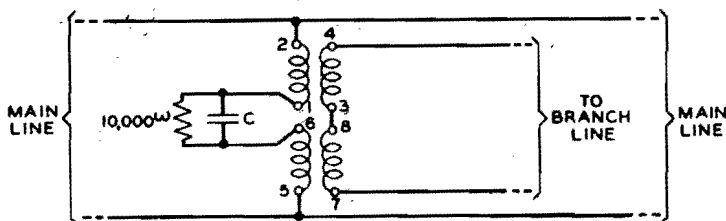
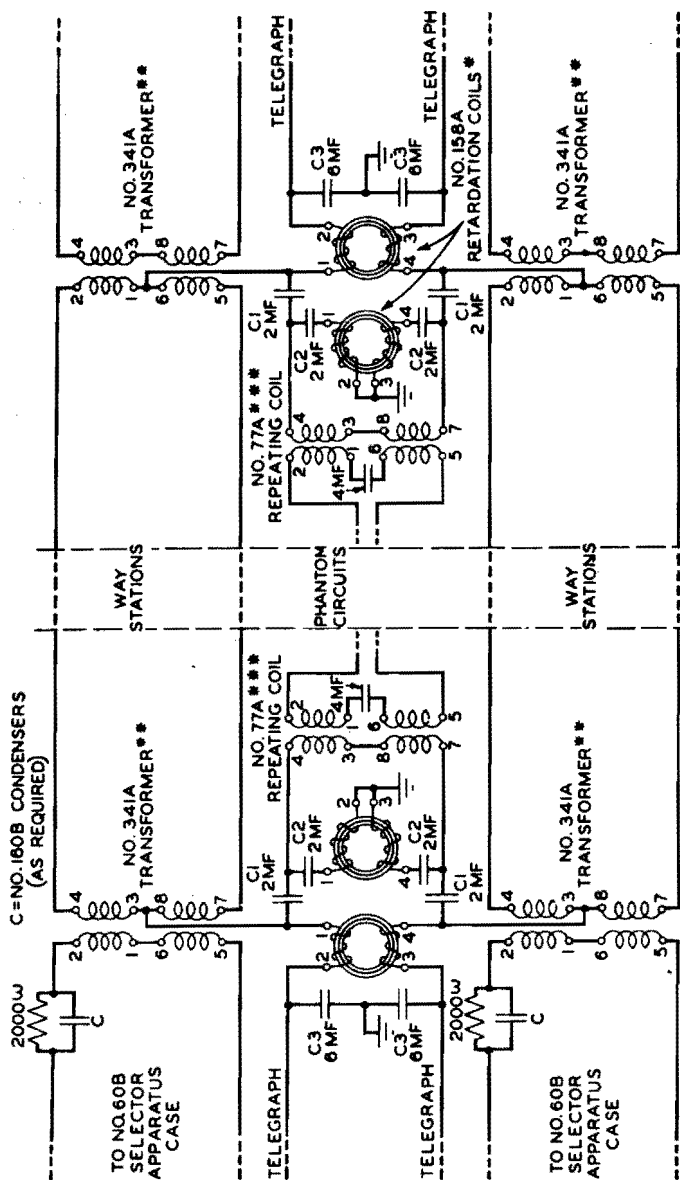


Figure 29—Branch Line Operated Through a Transformer



C1 = 2 NO.136QA OR 1 NO.33BJ OR 1/2 NO.33BS CONDENSER
 C2 = 2 NO.138A OR 1 NO.33BJ OR 1/2 NO.33BS CONDENSER
 C3 = 6 NO.136A OR 3 NO.33BJ OR 1 1/2 NO.33BS CONDENSER

* NO.77A RETARDATION COIL MAY BE USED
 ** NO.70A REPEATING COIL MAY BE USED
 *** NO.67C REPEATING COIL MAY BE USED

Figure 30—Composed Phantom Circuit

*Apparatus Shown on the Circuit Drawing Figures 31 and 32 of the
Railway Train Dispatching Telephone Systems Complete
with Selector Calling Equipment*

DISPATCHING STATION

- (1) No. 60B Selector Apparatus Case
 - 1.1 No. 221JB Relay
 - 1.2 No. 152A Retardation Coil
 - 1.3 No. 63F Resistance
 - 1.4 4 No. 138B Condensers
 - 1.5 No. 63C Resistance
 - 1.6 No. 138A Condenser
 - 1.7 No. 26A Telegraph Relay
 - 1.8 No. 141A Condenser
 - 1.9 No. 2B Circuit Breaker
 - 1.10 No. 709 Trumbull Switch
D.P.S.T.
- (2) Nos. 60A, B, C, D or E Selector
Key Case
 - 2.1 No. 60A or No. 60B Selector
Key and
No. 50A Selector Key
Spaces or
No. 61A or No. 61B Selector
Key or
No. 62A or No. 62B Selector
Key or
No. 63A or No. 63B Selector
Key
- (3) Use when Transformer Circuit is
required by connecting the "T"
Leads to the "L" Leads
 - 3.1 No. 341A Transformer or
No. 70A Repeating Coil
 - 3.2 DM-2000 Ward-Leonard
Resistance
 - 3.3 No. 160B Condensers or
No. 138B Condensers as
required
- (4) No. 502A Desk Set Box
(Subscriber Set)
 - 4.1 No. 43 Induction Coil
 - 4.2 No. 44 Induction Coil
 - 4.3 No. 140B Condenser
 - 4.4 No. 141B Condenser
 - 4.5 No. 141A Condenser
- (5) No. 345A Jack Box
- (6) Dispatcher Head Telephone Set
 - 6.1 No. 137 Plug
 - 6.2 No. 565 Cord
 - 6.3 No. 386 Transmitter

6.4 No. 189 Receiver

6.5 No. 3A Transmitter Attach-
ment

- (7) No. 6000A Key or
No. 1B Foot Switch and
No. 1A or No. 1B Foot Switch
Attachment and
No. 2A Foot Switch Attachment
- (7A) No. 127F Extension Bell and
No. 138A Condenser

WAY STATION

- (8) No. 501A Desk Set Box
(Subscriber Set)
 - 8.1 No. 42 Induction Coil
 - 8.2 No. 142B Condenser
 - 8.3 No. 1014A Push Button
- (9) No. 501B Desk Set Box
 - 9.1 No. 42 Induction Coil
 - 9.2 No. 142B Condenser
- (10) No. 3C Foot Switch
- (11) No. 1142AB Desk Stand
 - 11.1 No. D3D Cord
 - 11.2 No. 189 Receiver
 - 11.3 No. 349 Transmitter
 - 11.4 No. R2U Cord
 - 11.5 2 No. 427 Cords
- (12) No. 160C Selector Set or
No. 160R Selector Set
 - 12.1 No. 141H Condenser ($\frac{1}{2}$)
 - 12.2 No. 60CG Ringer
 - 12.3 No. 138B Condenser
 - 12.4 No. 60AP Selector*
 - 12.5 No. 60BP Selector*
*Not part of set.
- (13) No. 127J Extension Bell
 - 13.1 No. 21BA Condenser
 - 13.2 No. 60CG Ringer
- (14) No. 98B Protector
 - 14.1 2 No. 26 Protector Blocks
 - 14.2 2 No. 30 Protector Blocks
 - 14.3 2 No. 11C Fuses—
7 amperes
- (15) No. 299F Subscriber Set
(Hand Generator Box)

DISPATCHERS STATION

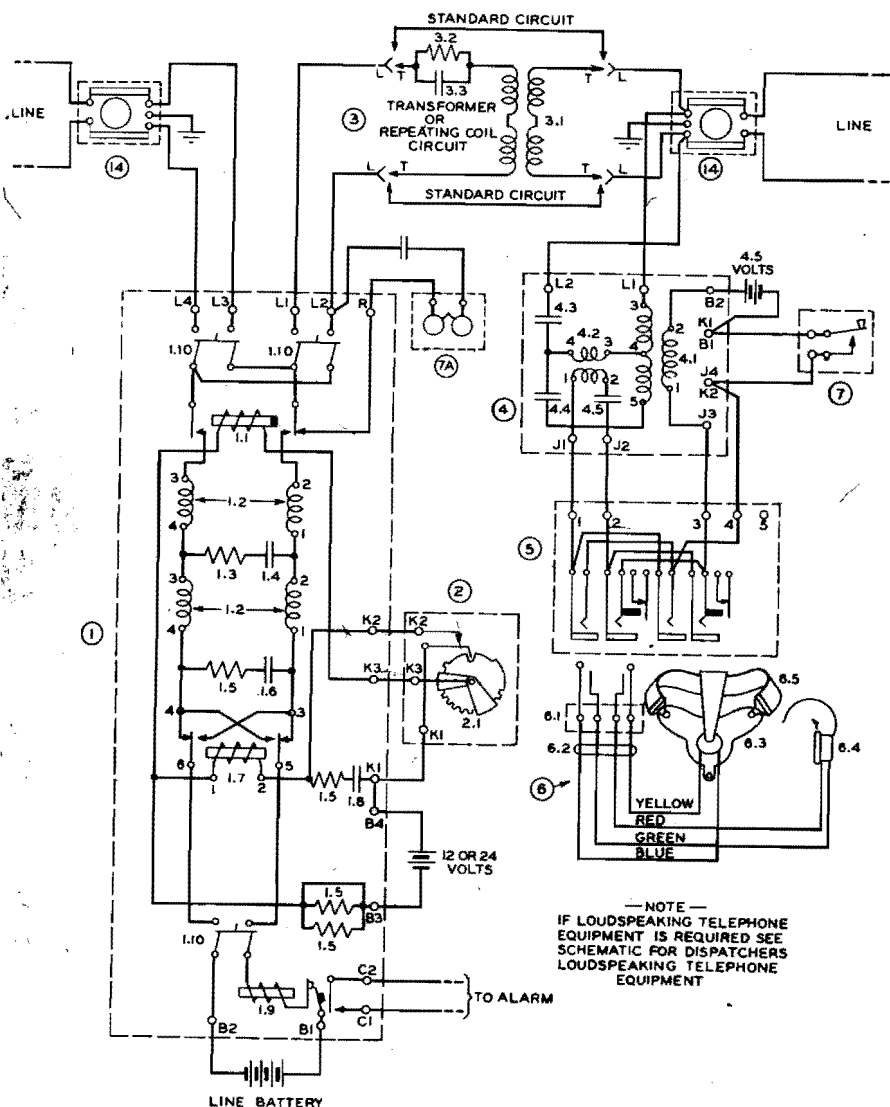


Figure 31—Schematic Circuit of Dispatcher's Station-Telephone and Selector Equipment

WAY STATIONS

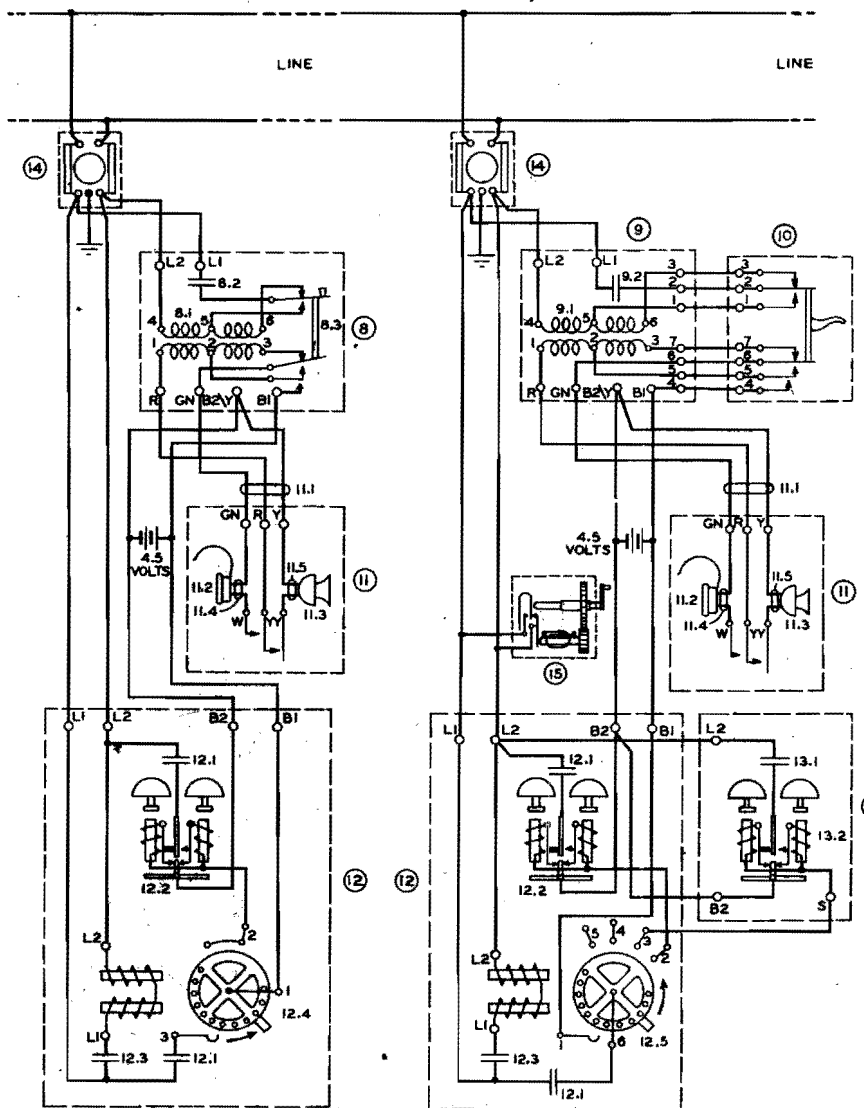


Figure 32—Schematic Circuit of Way Station-Telephone and Selector Equipment

TELEPHONE EQUIPMENT

As the telephone lines used for train dispatching systems may vary from a few miles to 200 or 300 miles in length and the number of stations on the lines may vary from a few to 40 or 60 stations or even more in some cases, it is necessary to use special telephone sets with such electrical

characteristics as to render the voices of both the dispatcher and the way station operators distinct and of as uniform a volume as possible for directing the operation of trains by telephone.

After a survey of existing systems and a consideration of the future growth of dispatching systems, an open wire line of 250



Figure 33—Way Station-Telephone Equipment

miles of No. 9 B. & S. gauge copper, with 40 stations evenly spaced, was taken as an average maximum condition to determine the type of set best suited to these conditions. In order to insure the most severe condition all way station sets were assumed to be simultaneously in a receiving condition.

The most desirable type of set to meet these conditions is a set which is variable between the receiving and the transmitting conditions, the impedance in the receiving position to be 7500 ohms with an angular relation of the total impedance to its resistance component of positive 70° at 800 cycles, and the impedance in the transmitting condition to be approximately 500 ohms with an angle of negative 12° .

NOS. 501A AND 501B DESK SET BOXES

The Nos. 501A and 501B Desk Set Boxes are for use at the way stations and have the electrical characteristics as described above best suited for a long line with any number of the way station telephone sets in a receiving condition.

The No. 501A Set has a No. 1014A Push-Button in the side of the set for changing from the receiving to the transmitting position and is suitable for mounting on the top of the desk within easy reach of the operator. The No. 501B Set is arranged for connecting to a No. 3C Foot Switch for changing from the receiving to the transmitting position and may be mounted at any convenient location. The sets are made of oak and are approximately $6\frac{1}{2}$

inches high by $5\frac{1}{2}$ inches wide by 3 inches deep.

The No. 501A Desk Set Box and the associated No. 1142AB Desk Stand used at the way stations are shown in Figure 33. The method of connecting them in the train dispatching system is shown schematically in Figure 32, together with a list of their component parts. The secondary winding of the induction coil in series with a No. 142B (0.25 mf) Condenser is permanently bridged across the line. With the receiver on the hook the transmitter and receiver circuits are opened by the contacts of the desk stand. The transmission characteristics of the system are not changed materially whether one or all of the sets are simultaneously in a receiving condition—that is, with the receivers off of the hook.

The induction coil insulates the operator's local equipment from any high voltages on the line as the telephone equipment is connected to the primary side of the induction coil. The induction coil has a breakdown of over 1,000 volts A.C. between the windings. The No. 142B Condenser is required to block the selector current impulses from being shunted through the telephone sets and to reduce the thumps caused by these impulses in the receiver.

When the push-button of the desk set box or the foot switch is operated to the transmitting position, the ratio of turns in the induction coil is changed so as to give a high transmission efficiency into the line. In this position, also, the receiver is put across the transmitter winding of the coil in order to give sufficient reception so that the dispatcher

may break in on an operator when talking.

The impedance at 800 cycles of the No. 501A or B Desk Set Box and No. 1142AB Desk Stand with the receiver off of the hook, is 7500 ohms in the receiving position, and approximately 500 ohms in the transmitting position.

The No. 1142AB Desk Stand consists of a No. 349 Transmitter with two No. 427 Cords, a No. 189 Receiver with a No. R2U Cord, and a No. D3D Desk Stand Cord. The maintenance parts are given in Figure 49.

Figure 34 shows the variation in the transmission equivalent at 800 cycles from the dispatcher's station to each way station along the above typical line when all station sets are evenly spaced and in a receiving condition. The curve shows that the farthest

station set on the line does not necessarily receive the smallest amount of power. Even with the stations unevenly spaced the maximum transmission equivalent would be no greater but may be at a different position on the line depending on the location of the sets.

Figure 35 shows several curves for the transmission equivalent at the last station of different lengths of open wire lines, No. 9 B. & S. gauge copper, with different numbers of way stations evenly spaced on the lines. The fact that the equivalent is greater on some of the shorter lines than on a longer line is due to the loading effect of this type of set on the line which actually tends to reduce the attenuation of the line. The minimum loss occurs in each case when the stations are approximately four miles apart.

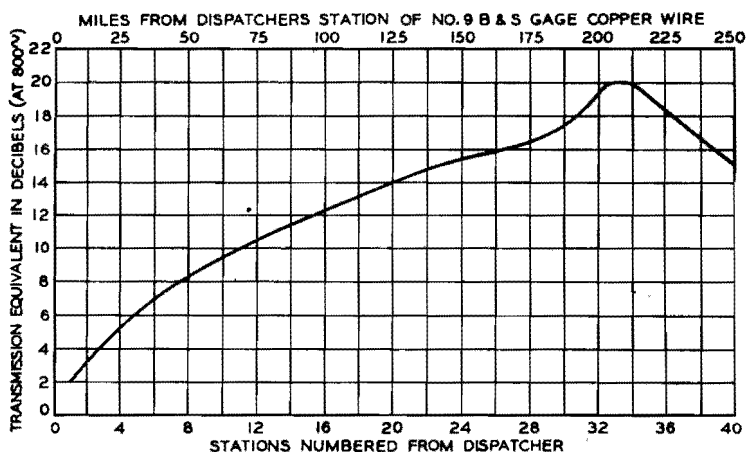


Figure 34—Curve of Transmission Equivalent from Dispatching Station to Each Way Station

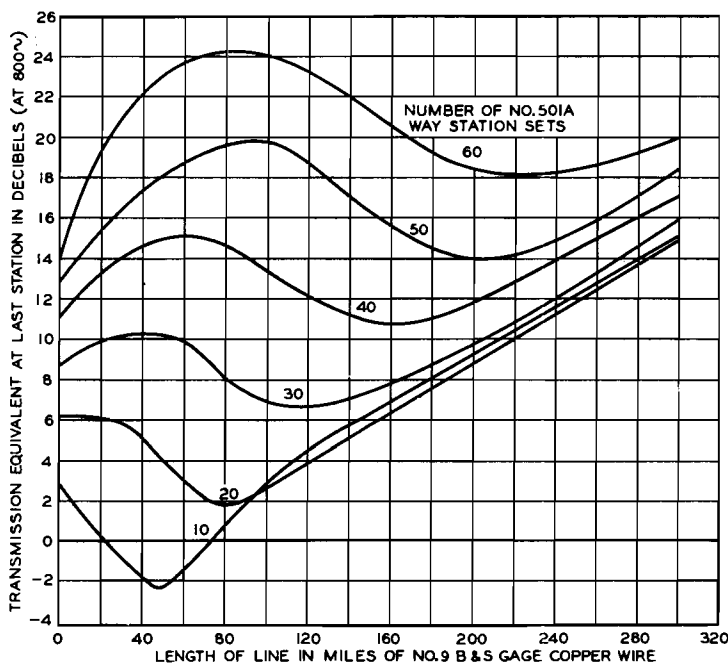


Figure 35—Curves of Transmission Equivalent at Last Way Station for Different Length of Lines and Number of Stations

No. 502A Desk Set Box (Subscriber Set)

The No. 502A Subscriber Set is for use at the dispatching station. The requirements for a dispatcher's telephone equipment differ from those of a way station set. The dispatcher is required to listen on his set practically continuously for eight-hour periods. It is necessary that in addition to high receiving efficiency, the "break-in" efficiency as well as the transmitting efficiency be as high as possible. Also, since there is only one dispatcher on the line, it is required that the dispatcher's set be designed to transmit and receive most efficiently when connected to an

impedance equal to that of the line. The impedance of open wire lines for the more severe conditions as regards length of line and number of stations varies from 925 to 1265 ohms with impedance angles varying from negative six to positive fifteen degrees.

To best meet these conditions an anti-side tone type of set is used. The operation of an anti-side tone circuit is based on the Wheatstone bridge principle, in which a balance is obtained between the line and a network in the set having the same impedance as that of the line. In such a case, little or no current will flow in the receiver from the



Figure 36—Dispatcher's Station-Telephone Equipment

electromotive force across the bridge, that is, from the transmitter since a balance or a near balance exists. Thus, the dispatcher's voice and any noise in the dispatcher's office are largely kept out of his receiver or loud speaker. On the other hand, any electromotive force in the line will cause current to flow through the receiver.

The No. 502A Subscriber Set and the associated telephone equipment used at the dispatcher's station are shown in Figure 36. The method of connecting them in the train dispatching system is shown schematically in Figure 31 together with a list of their component parts. The two induction coils insulate the dispatcher's local equipment from any high voltage on the line as the telephone equipment is connected to the primary sides of the induction coils. The induction coils have a breakdown of over 1,000 volts A.C. between the windings. The secondary windings of the No. 43 and No. 44 Induction Coils in series with a No. 140B Condenser (0.5 mf) are permanently bridged across the line. This line condenser is necessary to keep the selector signaling impulses from being shunted through the set and interfering with the selector operation, as well as to reduce the thumps in the dispatcher's receiver. The line condenser is balanced by a similar one (No. 141B Condenser) in the network arm of the set. The No. 141A Condenser in series with the receiver increases the receiving efficiency. The impedance of the set is approximately 875 ohms with an impedance angle of positive 27 degrees.

The No. 386 Transmitter is a low resistance insulated centrally damped local battery transmitter having a face, bell and chestplate of polished aluminum. It is equipped with a No. 3A Transmitter Attachment for holding it on the dispatcher's chest. The maintenance parts are given in Figure 48.

The No. 189 Receiver is a black finished metal head receiver unit with a rubber ear-piece, equipped with a No. 3B Headband. It has a single coil wound to a resistance of 45 ohms. If any parts are replaced care should be taken to insure that the distance between the core and the plane of the edge of the case is 0.009 to 0.010 inches. The diaphragm should be flat and free from dents or bends. The maintenance parts are given in Figure 48.

The No. 345A Jack Box permits the use of two operators' telephone sets in parallel and provides easy means for disconnecting the operator's head set. The No. 565 Cord and No. 137 Plug connects the No. 386 Transmitter, No. 189 Receiver and the No. 345 Jack Box.

The No. 6000A Key or No. 1B Foot Switch is used to close the local transmitter battery.

The transmitting efficiency of the No. 502A Subscriber Set and associated dispatcher's telephone equipment is approximately two db less than that of the No. 501A Desk Set Box and associated way station equipment; however, the receiving efficiency is approximately six db better. The side tone in the dispatcher's equipment is in the neighborhood of 15 db less than in the way station

equipment. The "break-in" of the dispatcher's equipment is the same as its receiving efficiency.

The possibility of using the way station set for a dispatcher has been considered. In certain cases it may give satisfactory service but since the requirements for a way station and a dispatcher's set are different, it does not seem advisable to use a way station set for a dispatcher. The lower side tone and the easier operating features of the No. 502A Set justify a different type of set from that used at the way station for the dispatcher.

The transmission equivalents given are based on results obtained from talking close to the mouthpiece of the transmitter. The efficiency of a transmitter decreases rapidly as the distance between the speaker's lips and the transmitter mouthpiece increases. The lips should be approximately $\frac{1}{2}$ inch from the mouthpiece. When the lips are 1, 2, 3 or 4 inches away from the mouthpiece, the loss in transmission efficiency will be $3\frac{1}{2}$ db, $6\frac{1}{2}$ db, 9 db and $11\frac{1}{4}$ db respectively. If the lips are held closer than $\frac{1}{2}$ inch to the mouthpiece, there is a loss in articulation or clearness of speech. Too much emphasis cannot be placed on the proper use of the telephone transmitter on such important circuits as those of train dispatching lines.

It is difficult to give tests for transmitters and receivers to be made in the field without adequate testing equipment. However, it is recommended that a transmitter or receiver that has been repaired or one whose operation is questionable be compared under the same circuit conditions

to an instrument that is known to give satisfactory service.

TELEPHONE AMPLIFIERS

Telephone amplifiers may be used in railroad signal towers, way stations and train dispatcher's offices to supplement the usual telephone outfit. They are designed to amplify the incoming speech so that a loud speaking telephone connected to them will produce sufficient volume to be heard at a distance of several feet, thus relieving the way station operator or the dispatcher of the necessity of wearing a head receiver.

This arrangement not only eliminates the physical discomfort and annoyance of wearing a headset continuously while on duty, but it gives the operator greater freedom of movement. It also does away with the objectionable effects due to surges in adjacent power lines since such noise is no longer impressed directly on the ear.

The amplification given by an amplifier is in general sufficient to give satisfactory loud speaking telephone operation where good volume is obtained from the headset and where the line and external noises are not excessive.

The input impedance of the amplifiers is such that a relatively large number of amplifiers may be connected across the telephone line without introducing excessive losses which might interfere with conversations carried on between stations at extreme ends of the line. Also, in view of the use of the line for selector operation, the input impedance of the amplifier has been so arranged that it will



Figure 37—No. 100E Loud Speaker Set

not offer any appreciable shunting effect to selector currents.

NO. 100E LOUD SPEAKER SET

The No. 100E Loud Speaker Set (Figure 37) consists of a two-stage resistance-coupled amplifier and a Jensen midget speaker mounted in a walnut finished cabinet. The approximate overall dimensions are $11\frac{1}{2}$ inches long by 7 inches high by $5\frac{1}{2}$

inches deep. The gain of the amplifier when operating from an impedance of 300 to 600 ohms is approximately 60 db.

The set will operate on a power supply of 105-125 volt, 25-60 cycle alternating current or on a power supply of 105-125 volt direct current. It is necessary to pole the power cord correctly when connecting the No. 100E Loud Speaker to a direct current

source. It is also desirable to pole the cord when using an alternating current source, since the noise with one polarity connection is generally less than with the opposite polarity connection. The power consumption is approximately 60 watts.

The power switch (right-hand knob) has three positions. In the first or off position (maximum counter-clockwise) the power supply is open. In the second position the power circuit is closed and sufficient current is provided to maintain the tube heating elements at a temperature where response may be obtained quickly from the amplifier when desired without shortening the life of the tubes. Also in the second position the signal lamp will light up with moderate brightness and the amplifier output is short circuited to prevent any response. In the third position, the heating elements of the tubes receive full current, the signal lamp assumes full brightness, the short circuit is removed from the output of the amplifier and the set is ready for operation.

The set may be put in operation if desired by turning the control knob directly to the third position; in this case approximately one minute will be required for the tube elements to heat up. The time required for the tubes to heat to operating temperature after switching from the second to the third position is less than five seconds, provided the set has been in the standby

(second position) for sufficient time.

The left-hand control knob may be used to increase or decrease the volume of the output of the set.

CONNECTIONS AT DISPATCHER'S STATION

The No. 100E Loud Speaker Set, the No. 34H Resistance, No. 142D Condenser, No. 12E Connecting Block and the No. 6017B Key should be connected with the usual telephone equipment at the dispatcher's station as shown in Figure 38. The amplifier is connected in the balanced side of the No. 502A Subscriber Set in place of the No. 189 Receiver and a switch is provided so that either amplifier or receiver may be used.

The No. 142D Condenser (0.05 mf) reduces the thumps in the loud speaker caused by the selector signalling impulses.

The No. 6017B key provides a means for switching from the loud speaker set to the head receiver.

The No. 34H Resistance shunts the input of the amplifier and its purpose is to provide an adjustment for the loud speaker volume. As indicated in Figure 44 the three connections to the resistance are adjustable and should be placed on their proper taps by trial as follows. With the power supply turned on, the No. 6017B Key set to connect the amplifier, and the volume control set for full

gain of the amplifier, lead No. 1 should be connected to give a total shunting resistance of from 40 to 100 ohms on the No. 34H Resistance so that the volume from the nearby station will not be too loud and at the same time the volume from the most distant station will be satisfactory.

With the foot switch operated and a distant station talking, lead No. 2 should be connected so that sufficient volume is obtained for break-in purposes from a distant station and at the same time so that the loud speaker will not howl when the dispatcher is speaking. With the No. 2 lead connected so as to reduce the shunting resistance to 10 or 20 ohms, howling will usually not occur, and sufficient volume will be obtained for break-in purposes.

The No. 3B foot switch connects the battery to the transmitter and lowers the value of the shunting resistance across the input of the loud speaker set to prevent howling when the dispatcher is talking. The foot switch must be depressed to talk and released to receive, although reception at a reduced volume for "break-in" purposes may be had while the switch is depressed.

With the 100E Loud Speaker Set connected as described, adequate reception and "break-in" by any way-station operator should be obtained by the dispatcher over 200 miles of line.

CONNECTIONS AT WAY STATION

The No. 100E Loud Speaker Set, when used with the usual telephone equipment at a way station, should be connected directly across the line in series with a 141H Condenser with its two units connected in series to give a capacity of 0.01 mf. The condenser reduces the thump in the loud speaker caused by the selector signalling impulses and prevents the shunting of these impulses by the loudspeaker set.

The No. 3D Foot Switch should replace the No. 3C Foot Switch shown as item 10 on Figure 32 (page 55), and the added terminals 8 and 9 should be connected to the input terminals 1 and 2 of the No. 100E Loud Speaker Set. With the input of the set short-circuited the operator when talking will receive any break-in by the dispatcher by means of the No. 189 Receiver.

When the amplifier is not in use keep the power turned off in order to conserve the life of the vacuum tubes.

If the amplifier fails to operate, test the power supply and the associated polarity, particularly if the power supply is from a direct-current source. Should the signal lamp and the heater element of the tubes fail to light, remove the back cover plate and insert new tubes successively in their respective sockets to determine whether or not the heater element of any one tube has opened the series heater circuit.

If the amplifier fails to operate after replacement of all three vacuum tubes and the heater element of the vacuum tubes are operating at their normal brilliancy the operator should not in general try to correct the trouble himself but should obtain the services of the nearest distributor.

To insure continuous service from the amplifier it is recommended that spare Raytheon C. K. 108, No. 43 and No. 25-Z-5 tubes be kept on hand.

The power supply cord may be ordered as a No. M2CB Cord.

Information for ordering any other apparatus units in the No. 100E Loud Speaker Set is given in Figure 38.

Foot Switches

The No. 1 and No. 3 Type Foot Switches are used for making the necessary connections between the local battery, transmitter, and subscriber set and to change from the receiving to the transmitting position at the dispatcher's station or way station. Each foot switch is comprised of two contact spring pileups; the switches differ only in the spring combination controlled by the foot pedal. The contact springs have a breakdown of over 1,000 volts AC between the springs and between the springs and frame. The foot switches are enclosed in a black finished metal case approximately $7\frac{1}{2}$ inches high, $3\frac{3}{4}$ inches wide and 3 inches in depth (not

including the pedal). The maintenance parts for the following foot switches are given on page 96, Figure 50.

The No. 1B Foot Switch is equipped with a single make contact and is used with the No. 502A Subscriber Set at the dispatcher's station to connect the battery to the transmitter for talking. When the contact springs are open the minimum distance between contact points should be $\frac{1}{32}$ inch and when contact is made there should be a minimum travel of $\frac{1}{32}$ inch after contact is made. The maximum travel of the springs measured at the contact points should be $\frac{1}{8}$ inch.

The No. 3B Foot Switch makes two and breaks one contact, and is used when a loud speaking telephone set is connected to the No. 502A Subscriber Set at the dispatcher's station. The switch connects the battery to the transmitter for talking and also reduces the shunt resistance across the input or output of the particular type of loud speaking telephone used. When the contact springs are open the minimum distance between contact points should be $\frac{1}{32}$ inch and when contact is made there should be a minimum travel of $\frac{1}{32}$ inch after contact is made. The maximum travel of the springs measured at the contact points should be $\frac{1}{8}$ inch. The normally closed contact of the three-spring pileup should open before the contact of the two-spring pileup closes, which in turn

should close before the normally open contact of the three-spring pileup closes.

The No. 3C Foot Switch makes three and breaks two contacts, and is used in conjunction with a No. 501B Subscriber Set at the way station. The switch connects the battery to the transmitter for talking and changes the turns ratio of the induction coil to increase the efficiency of the set when transmitting and receiving. When the contact springs are open, the minimum distance between the contact points should be $\frac{1}{32}$ inch and when the contact is made there should be a minimum travel of $\frac{1}{32}$ inch after contact is made. The maximum travel of the springs measured at the contact points should be $\frac{1}{8}$ inch. The normally closed contact of the three-spring pileup should open before the normally open contact is made. The normally closed contact of the four-spring pileup should open before the normally open contacts are made.

The No. 3D Foot Switch makes four and breaks two contacts, and is used when a loud speaking telephone is connected to the No. 501B Subscriber Set at a way station. The switch connects the battery to the transmitter for talking, changes the turns ratio of the induction coil to increase the efficiency of the set when transmitting and receiving, and short circuits the input or output of the particular type of loud speaking telephone used. When the contact springs are open, the minimum distance between the contact points should be $\frac{1}{32}$ inch and when contact is made there should be a minimum travel of

$\frac{1}{32}$ inch after contact is made. The maximum travel of the springs measured at the contact points should be $\frac{1}{8}$ inch. The normally closed contact of the five-spring pileup should open before the normally open contact associated with the same operating spring is made. The normally closed contact of the four-spring pileup should open before the normally open contacts are made.

No. 1A and No. 1B Foot Switch Attachments

The Nos. 1A and 1B Foot Switch Attachments are steel bars pivoted at each end and operate against the pedal of the foot switch.

No. 2A Foot Switch Attachment

The No. 2A Foot Switch Attachment is a $\frac{3}{4}$ -inch black enameled conduit equipped with a $\frac{3}{4}$ -inch T and B bushing at one end and also includes a pipe strap and screw for mounting. It is used to protect the wires entering the foot switch.

MAINTENANCE TESTS

Periodic Tests

It is recommended that regular periodic tests be made of the line and the apparatus in the calling circuit as follows:

Test 1

Line tests should be made daily, as the line, as a rule, is subject to extreme variations due to its exposure to variable weather conditions, interference from outside sources, etc. No attempt will be made here to indicate the best way to determine the faults in the line such as opens, shorts,

crosses, leaks, etc., as this depends in a great measure on the local conditions and the testing apparatus available.

Test 2

Test (every two weeks) the potential of the local and main batteries when the normal operating current is flowing.

Test 3

Test (once a month) by operating each No. 60 Type Selector Key, to determine for the regular stepping impulses, that the length of time during which the positive potential is on the line is equal to the time during which the negative potential is on the line, as described on page 12 under heading "No. 26-A Telegraph Relay." If the results for all keys are the same, the local battery in good condition, and the times that the positive and negative potentials are on the line are not equal, then the No. 26-A Relay should be adjusted by changing the magnetic air-gap. However, if a few keys give unequal results, the K1 and K2 contact on these keys should be adjusted to give the same results as the other keys. (See Selector Keys, page 14.)

Test 4

Test (once a month) the time of one complete operation of each selector key. The time should be within the allowable variation given for that particular selector key. If not, adjust the governor springs, as described, to make it so. A convenient way to do this is to make sure that one key is right by timing its operation with a stop watch, if one is available; or if not, with an ordinary watch and then testing the remaining

keys by winding this key up with one hand and the key under test with the other hand and then releasing both at the same time and seeing if they complete their operation at approximately the same time.

NOTE: If the keys become noisy in operation, a little Eagle No. 3 Spindle Oil or watch oil on the worm and gears will help. The amount of oil used should be exceedingly small and no other kind of oil should be used under any circumstances for the reason that heavier oils tend to become gummy.

Test 5

Another test should be made when the selectors are installed and from time to time (say every 3 months) thereafter. After the line tests and tests on apparatus in the calling circuit are made and each found satisfactory, the potential of the main battery should be reduced by from 50 to 75 volts, or by such value as the local conditions warrant, and each station should then be called in turn. If there is a failure it will show that some of the apparatus has not the proper margin of operation above the minimum operating voltage. This test will give an opportunity to investigate any weak points that may exist so that they may be remedied and thus avoid future failure due to some unavoidable line or other trouble that may occur. This is a Safety First Test.

Tests of this nature are maintenance tests and if carried out consistently may forestall causes of trouble and thus prevent interference with service.

Tests for Failure of Operation

When a call is made and the bell does not ring, or no answer-back is heard in the receiver, it is an indication that there is trouble somewhere in the system.

First, notice if the usual dull thumps are heard in the receiver when a key is operated; if not, this is an indication that battery current is not being supplied to the line. The battery connections and operations of the relays in the calling circuit should be examined.

Then call the stations on each side of the station that failed and if these do not respond, it is an indication of line trouble or else trouble in the calling apparatus. Test the line wires and if no trouble is found, test the apparatus in the calling circuit as described under Periodic Tests 2, 3 and 4.

If the stations on each side of the station that failed, respond, it is an indication of trouble with that selector key or else in the apparatus at that way station. This key should be tested as described under Periodic Tests 2 and 3. If the key is operating satisfactorily, have the call made for that station and observe if the selector steps up properly to the ringing position; if it does and the bell does not ring, test the bell by making a metallic connection between terminals 1 and 2 on the selector. If the bell then rings, it shows a poor contact or loose connections on the selector. The wiring to the contact springs and the contact itself should then be examined.

If the bell does not ring when a connection is made between ter-

minals 1 and 2 on the selector, test the local battery and examine operation of the bell and the answer-back. (See No. 60CG Ringer, page 28.)

If it is possible to call the stations on each side of the station that fails and the selector key for this selector and the bell circuit are operating properly, it indicates that the selector is at fault. If the selector does not move at all when a call is made, it indicates an open in the selector circuit at the way station.

To determine whether current is flowing through the selector, a reading may be taken with a milliammeter. It is difficult to measure the current through the selectors, due to the very small current and the fact that each impulse of current is of short duration and in an opposite direction to the preceding one. However, with a zero-center 10 milli-ampere-scale ammeter the swing of the needle on each side of the zero point should be equal for the regular stepping impulses. The value of the reading will depend on the damping of the meter and a minimum value can only be obtained by trial.

If a voltmeter is used to measure the potential at the station where failure has occurred, a high resistance meter, say not less than 15,000 ohms, must be used. A zero-center-scale meter is preferable and, in this case also, the swing of the needle on each side of the zero point should be equal for the regular stepping impulses. However, the amount of the swing will depend somewhat on the damping of the meter and a definite value cannot be given.

A minimum value can be obtained from trial.

As a general thing, adjustment of the selector in the field is not recommended. However, if the cause of failure of operation of the selector is quite obvious, there is no objection to correcting the trouble at once. Extreme care should be taken in adjusting the selector.

If the cause of the failure is not easily seen or easily corrected, we recommend that a spare selector be substituted and that the selector which failed to operate be returned for investigation. When a selector is returned, a statement of the conditions and, as nearly as possible, the manner in which the selector acted, should be sent along with the selector to aid in determining the cause of failure.

Effect of Line or Wire Troubles

When a wire goes down or becomes open in any other way, the line as a rule becomes noisy and the stations beyond the break cannot be called. All stations can usually be called, however, up to the break.

When a short circuit occurs on the line near the dispatcher there may be considerable sparking of the contacts when a call is made and no selector can be called. When a short circuit occurs further out on the line some of the nearby selectors may be operated, depending upon the length of the line.

It frequently happens that telegraph wires break, swing or otherwise become crossed with telephone wires. If the telegraph battery is very high the operation of the selectors may be interfered with by telegraph impulses, especially if the telegraph impulses are reversed frequently.

If the insulation of the line is low but essentially the same for both line wires, there will be no effect on the calling system except, of course, that the selectors at the far end of the line will receive less current. The current margin of the selectors should, however, be sufficient to take care of this. An unbalanced leak (that is, where the leak from one line wire is greater than from the other), will, as a rule, cause the line to become noisy, but should not affect the operation of the selectors.

PARTS FOR MAINTENANCE

*Spare parts that may be required for maintenance
of the main apparatus units are given in
the following pages.*

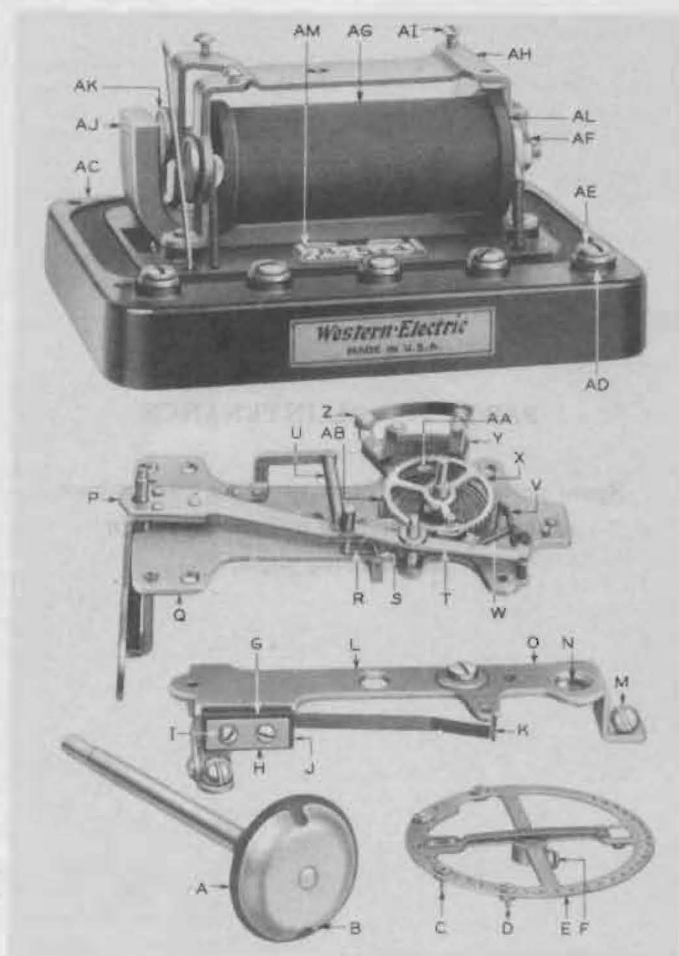


Figure 39—No. 60 Type Selector

<i>No.</i>	<i>Subject</i>	<i>No. 60AP Selector</i>	<i>No. 60BP Selector</i>
A	Felt washer	P-91966	P-91966
B	Clamping stud	P-207899	P-207899
C	Code pin	P-137652	P-137652
D	Code nut	P-137651	P-137651
E	Code wheel	P-146196	P-146199
F	Code wheel screw	P-137650	P-137650
G	Insulator bushing	P-207896	P-207896
H	Clamping plate	P-146610	P-146610
I	Clamping plate screw	P-93833	P-93833
J	Insulator	P-137632	P-137632
K	Holding spring	P-137636	P-137636
L	Upper plate	P-146308	P-146308
M	Upper plate screw	P-147796	P-147796
N	Adjusting screw	P-92642	P-92642
O	Hex. nut	P-137686	P-137686
P	Armature	P-146148	P-146148
Q	Middle plate	P-146306	P-146306
R	Holding pawl	P-137643	P-137643
S	Holding pawl spring	P-247900	P-247900
T	Rocker arm assembly	P-146152	P-146152
U	Rocker arm spring	P-247899	P-247899
V	Stepping pawl	P-146149	P-146149
W	Stepping pawl spring	P-247901	P-247901
X	Ratchet assembly	P-137678	P-137678
Y	Terminal plate	P-137658	P-143503
Z	Terminal bridge screw	P-94505	P-94505
AA	Terminal plate screw	P-93836	P-93836
AB	Spiral spring	P-216750	P-216750
AC	Base	P-207897	P-207898
AD	Base terminal	P-137683	P-137683
AE	Terminal screw	P-137685	P-137685
AF	Core lock nut	P-121772	P-121772
AG	Coil	P-228520	P-228520
AH	Frame	P-146145	P-146145
AI	Frame screw	P-121770	P-121770
AJ	Magnet	P-145918	P-145918
AK	Core	P-147431	P-147431
AL	End play washer	P-137641	P-137641
AM	Card	P-92152	P-92152
	Card holder	P-101963	P-101963
	Face strip	P-101964	P-101964
	Retaining screw	P-223064	P-223064
	Glass cover	P-162258	P-162258

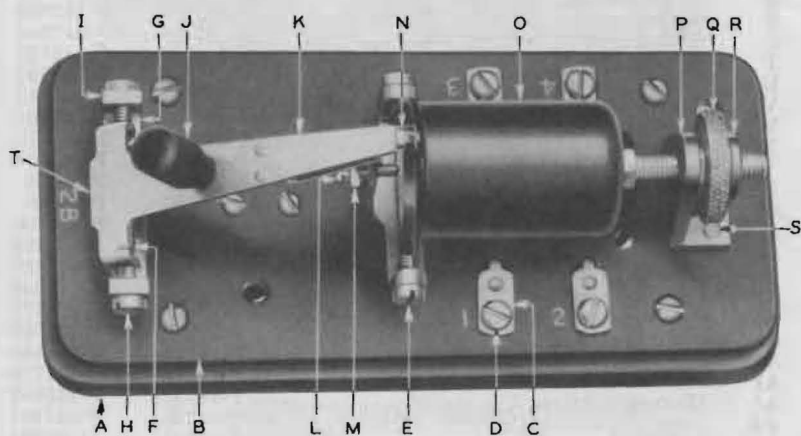


Figure 40—No. 2B Circuit Breaker

<u>No.</u>	<u>Subject</u>	<u>No. 2B Circuit Breaker</u>
A	Sub-base.....	P-95346
B	Base.....	P-227865
C	Binding post.....	P-229128
D	Screw.....	P-228895
E	Trunnion screw.....	P-95320
F	Helical spring.....	P-95336
G	Screw.....	P-95337
H	Pivot screw.....	P-95335
I	Trunnion bracket.....	P-95334
J	Handle.....	P-132717
K	Arm.....	P-227867
		P-95338
		* P-95339
		P-95340
L	Adjusting screw.....	P-95321
M	Adjusting nut.....	P-95322
N	Armature.....	* P-95326
		* P-95327
O	Coil.....	P-95316
P	Adjusting bracket.....	P-95330
Q	Adjusting nut.....	P-95333
R	Tension bracket.....	P-95331
S	Bracket screw.....	P-95332
T	Alarm stud.....	P-227868
Spring Pileup		
	Screw.....	P-139931
	Insulator.....	P-133451
	Clamping plate.....	P-107040
	Bushing.....	P-13549
	Upper contact spring.....	P-166669
	Lower contact spring.....	P-148240

*To be assembled.

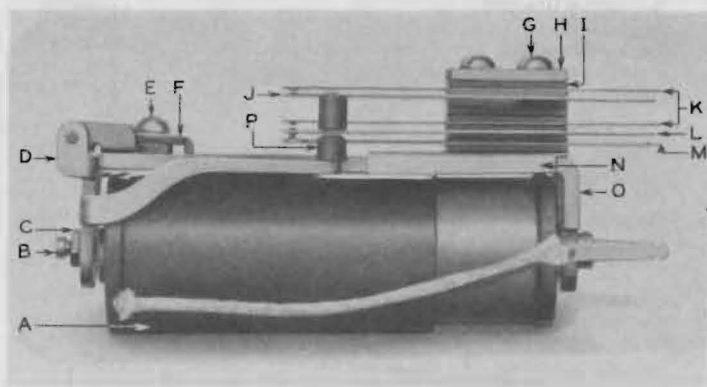


Figure 41—No. 221JB Relay

<u>No.</u>	<u>Subject</u>	<u>No. 221JB Relay</u>
A	Coil	P-250737
B	Armature travel screw	P-250207
C	Armature travel nut	P-250211
D	Armature	P-252502
E	Armature screw	P-92619
F	Clamping washer	P-250208
G	Pileup screw	P-250715
H	Clamping plate	P-251737
I	Insulator	P-250212
		P-252113
J	Contact spring	* P-252110
		P-250310
K	Contact spring	P-252112
L	Contact spring	P-252115
M	Contact spring	P-252114
N	Armature stop	P-250206
O	Pole piece	P-250260
P	Armature plug	P-252109

*To be assembled.

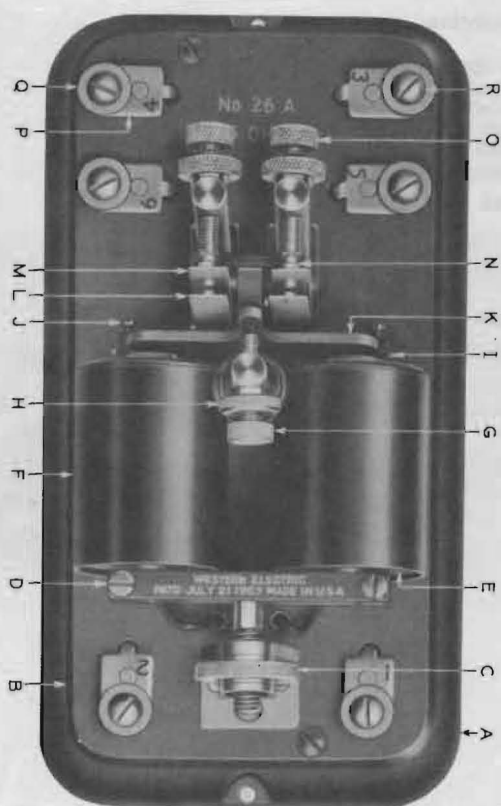


Figure 42—No. 26A Telegraph Relay

<u>No.</u>	<u>Subject</u>	<u>No. 26A Telegraph Relay</u>
A	Sub-base.....	P-95884
B	Base.....	P-97467
C	Adjusting nut.....	P-95889
D	Coil mounting screw.....	P-95965
E	Coil.....	P-98584
F	Coil shell.....	P-95919
G	Stop screw.....	P-97484
H	Check nut.....	P-95899
I	Bearing.....	P-95930
J	Bearing screw.....	P-99930
K	Armature.....	P-97470
L	Contact spring.....	P-247792
M	Contact spring.....	P-247793
N	Bone stud.....	P-97471
O	Contact screw.....	P-290205
P	Binding post.....	P-97927
Q	Binding post washer.....	P-97937
R	Binding post screw.....	P-118454
	Clamp plate.....	P-92343
	Pile-up screw.....	P-116879
	Bushing.....	P-93293
	Small insulator.....	P-97478
	Large insulator.....	P-97477
	Base terminal clip.....	P-95903
	Coil support.....	P-95904

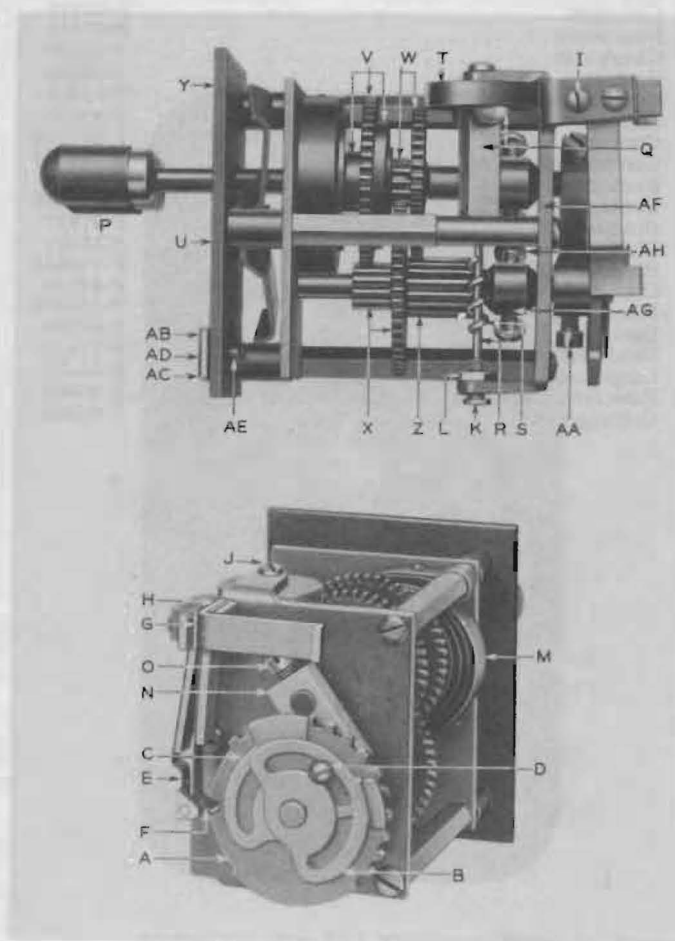


Figure 43—No. 60 Type Selector Key

<u>No.</u>	<u>Subject</u>	<u>No. 60A Selector Key</u>	<u>No. 60B Selector Key</u>
A	Impulse wheel.....	*P-140791	*P-140944
B	Bent-up segment.....	P-140789	P-140942
C	Flat segment.....	P-140788	P-140941
D	Segment screw.....	P-115851	P-115852
E	Contact spring.....	P-140782	P-140782
F	Contact spring.....	P-140784	P-140784
G	Insulator bushing.....	P-140787	P-140787
H	Insulator.....	P-132308	P-132308
I	Pileup screw.....	P-115587	P-115587
J	Governor pivot.....	P-93028	P-93028
K	Governor pivot.....	P-93044	P-93044
L	Pivot lock nut.....	P-92122	P-92122
M	Main spring.....	P-93040	P-93040
N	Stop.....	P-219298	P-219298
O	Stop screw.....	P-219300	P-219300
P	Handle.....	P-94751	P-94751
Q	Governor.....	P-93393	P-93393
R	Governor shaft.....	**{P-93020	**{P-93020
S	Governor worm.....	**{P-93021	**{P-93021
T	Governor cup.....	P-92113	P-92113
U	Mounting screw.....	P-92132	P-92132
V	Ratchet gear and shaft.....	*P-93033	*P-93033
W	Gear and pinion.....	P-93036	P-93036
X	Gear and pinion.....	P-93050	P-93050
Y	Face plate.....	P-98914	P-98914
Z	Worm wheel.....	P-93024	P-93024
AA	Screw.....	P-93487	P-93487
AB	Card.....	P-92152	P-92152
AC	Card holder.....	P-101963	P-101963
AD	Face strip.....	P-101964	P-101964
AE	Retaining screw.....	P-107474	P-107474
AF	Rear bearing plate.....	*P-93027	*P-93027
AG	Distance collar.....	*P-93042	*P-93042
AH	Distance collar screw.....	*P-93382	*P-93382
	Large flat segment.....		P-142175

*Keys not equipped with the code wheel stop (N) require the following parts in place of the parts listed above.

A	Impulse wheel.....	P-248307	P-248308
V	Ratchet gear and shaft.....	P-248302	P-248302
AF	Rear bearing plate.....	P-248301	P-248301
AG	Distance collar.....	P-248297	P-248297
AH	Distance collar screw.....	P-248298	P-248298

**To be assembled.

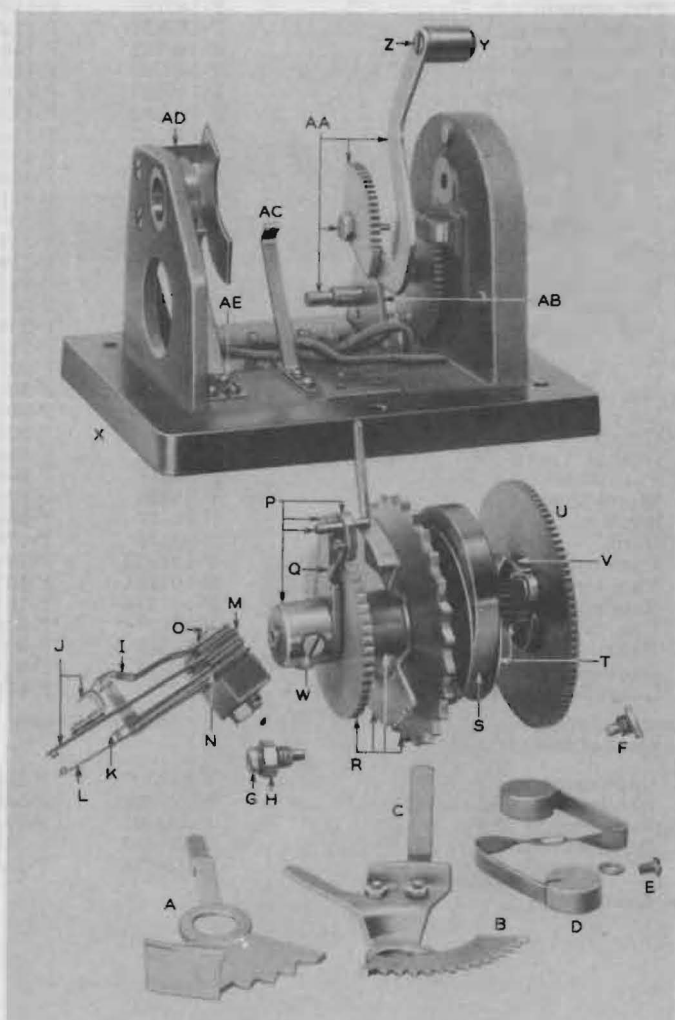


Figure 44—No. 61 Type Selector Key

<u>No.</u>	<u>Subject</u>	<u>No. 61A Selector Key</u>	<u>**No. 61B Selector Key</u>
A	Code lever.....	Det. 49, A-121562	Det. 49, A-121566
B	Code lever.....	Det. 34, A-121560	Det. 34, A-121565
C	Interlock arm.....	Det. 61, A-121563	
D	Governor.....	*Det. 2 & 4, A-121555	
E	Governor screw.....	P-115577	
F	Pivot screw.....	Det. 55A, A-121562	
G	Pivot screw.....	Det. 55, A-121562	
H	Pivot nut.....	P-95329	
I	Locking spring.....	Det. 47, A-121561	
J	Contact spring.....	*Det. 39 & 46, A-121561	
K	Contact spring.....	*Det. 40A, A-121561	
L	Contact spring.....	*Det. 38, A-121561	
M	Insulator.....	Det. 41, A-121561	
N	Bushing.....	Det. 43, A-121561	
O	Pile-up screw.....	P-116361	
P	Pawl assembly.....	*Det. 28-29-30-32-33 & 33A, P-93204, P-130314, A-121559	
Q	Pawl spring.....	P-93204	
R	Impulse and ratchet wheels.....	*Det. 34-35-36-37, A-121560	*Det. 34-35-36-37, A-121565
S	Main spring.....	Det. 21, A-121558	
T	Spring holder and ratchet.....	*Det. 19-20-22-23-25, A-121558	
U	Governor gear.....	*Det. 8-9-10-11-10A, A-121556	
V	Ratchet spring.....	P-93030	
W	Hub screw.....	0.138 inch-32 x $\frac{1}{4}$ inch, A-121569	
X	Base.....	Det. 1, A-124869	
Y	Handle.....	P-101504	
Z	Handle screw.....	P-101482	
AA	Operating lever.....	*Det. 12-13-14-16-17- 18-19, A-121557	
AB	Latch spring.....	P-93203	
AC	Position spring.....	Det. 50, A-121562	
AD	Fixed segment.....	Det. 51, A-121562	Det. 51, A-121566
AE	Spring screw.....	P-115578	
	Cover.....	Det. 1A, A-124867	Det. 1A, A-124868
	Right code plate.....	Det. 57, A-127563	Det. 57, A-121567
	Middle code plate.....	Det. 56, A-121563	Det. 56, A-121567
	Left code plate.....	Det. 59, A-121563	Det. 59, A-121567
	Code plate screw.....	Det. 58, A-121563	

*To be assembled as per the drawing A-121569.

**Parts same as for No. 61A Selector Key except as noted below.

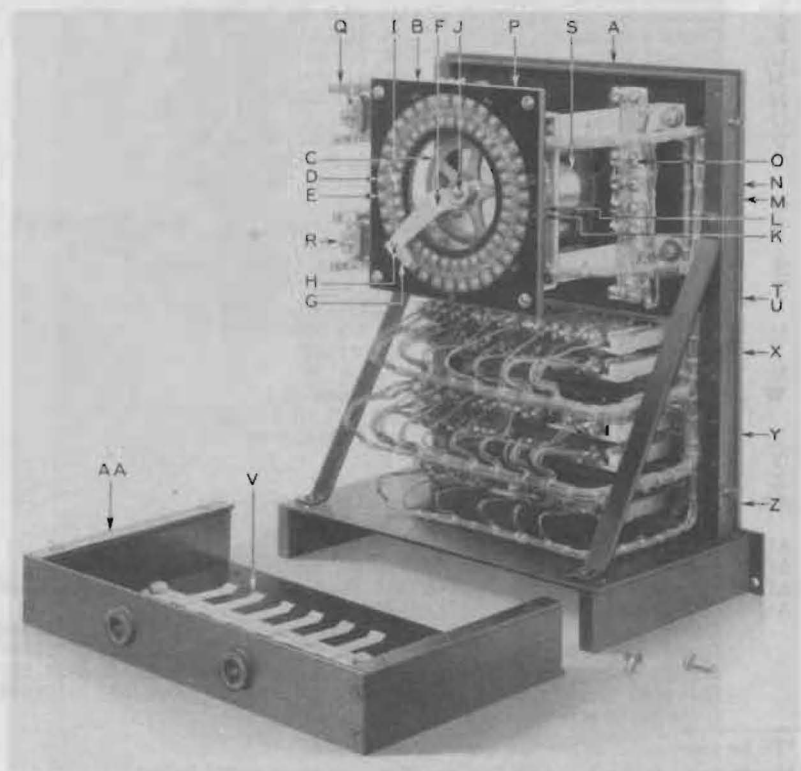


Figure 45—No. 62 Type Selector Key

<u>No.</u>	<u>Subject</u>	<u>No. 62A Selector Key</u>	<u>No. 62B Selector Key</u>
A	Distributor panel—Complete..	P-235881	P-235881
B	Terminal plate—Complete....	P-235864	P-235864
C	Inner segment.....	P-235866	P-235866
D	Outer segment.....	P-235865	P-235865
E	Segment screw.....	P-115586	P-115586
F	Contact arm.....	P-235868	P-235868
G	Contact spring.....	P-235869	P-235869
H	Contact spring screw.....	P-114485	P-114485
I	Gear.....	P-235867	P-235867
J	Gear mounting screw.....	P-119251	P-119251
K	Pinion mounting screw.....	P-157519	P-157519
L	Pinion.....	P-235870	P-235870
M	Designation card.....	P-244445	P-244445
N	Window.....	P-235883	P-235883
O	Terminal.....	P-124619	P-124619
P	Resistance—Ward Leonard....	Type O-45 ohms	Type O-45 ohms
Q	Relay—Start.....	No. R-1027	No. R-1027
R	Relay—Stop.....	No. R-332	No. R-332
S	Telechron Motor—Type B3— 1 RPS.....	60 cycle 110 volts	60 cycle 110 volts
T	Lamp.....	No. 2F	No. 2F
U	Lamp socket.....	No. 13A	No. 13A
V	Base terminal spring.....	P-235856	P-235856
X	Key panel—Red buttons.....	No. 542A Key	No. 543A Key
Y	Key panel—White buttons....	No. 542B Key	No. 543B Key
Z	Key panel—Black buttons....	No. 541A Key	No. 541A Key
AA	Base—Complete.....	P-235859	P-235859
	Cover.....	P-235843	P-235843
	Circuit label.....	P-244441	P-244442

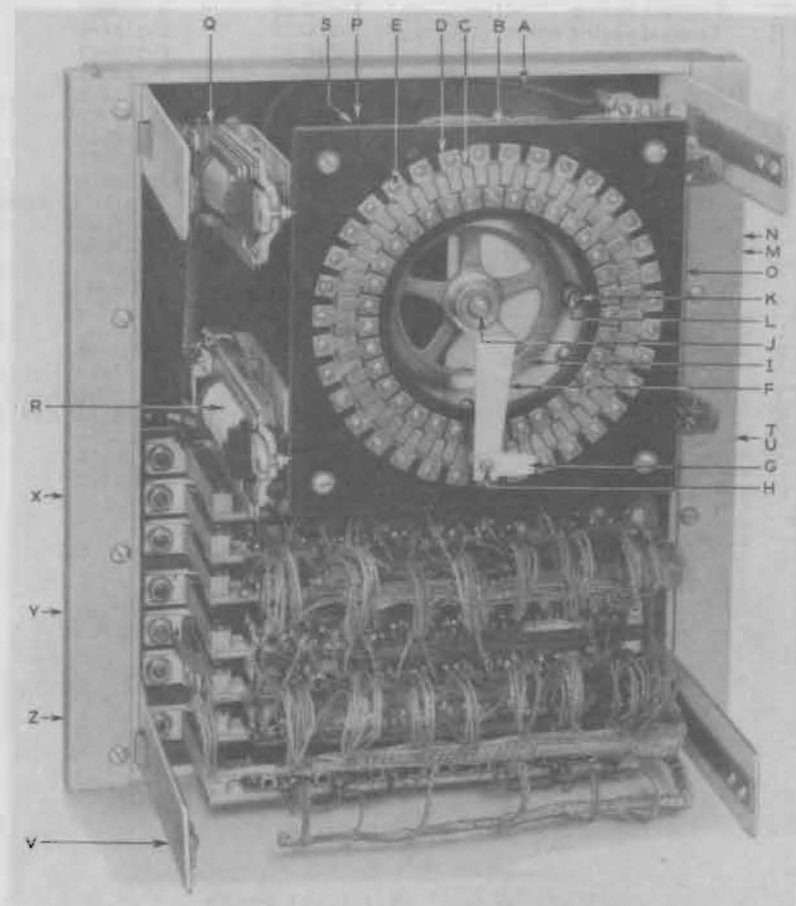


Figure 46—No. 63 Type Selector Key

<u>No.</u>	<u>Subject</u>	<u>No. 63A Selector Key</u>	<u>No. 63B Selector Key</u>
A	Distributor panel—Complete..	P-235880	P-235880
B	Terminal plate—Complete....	P-235864	P-235864
C	Inner segment.....	P-235866	P-235866
D	Outer segment.....	P-235865	P-235865
E	Segment screw.....	P-115586	P-115586
F	Contact arm.....	P-235868	P-235868
G	Contact spring.....	P-235869	P-235869
H	Contact spring screw.....	P-114485	P-114485
I	Gear.....	P-235867	P-235867
J	Gear mounting screw.....	P-119251	P-119251
K	Pinion mounting screw.....	P-157519	P-157519
L	Pinion.....	P-235870	P-235870
M	Designation card.....	P-244445	P-244445
N	Window.....	P-235883	P-235883
O	Terminal.....	P-124619	P-124619
P	Resistance—Ward Leonard....	Type O-45 ohms	Type O-45 ohms
Q	Relay—Start.....	No. R-1027	No. R-1027
R	Relay—Stop.....	No. R-332	No. R-332
S	Telechron Motor Type B3, 1 RPS.....	{ 60 cycle 22 volts	{ 60 cycle 22 volts
T	Lamp.....	No. 2F	No. 2F
U	Lamp socket.....	No. 13A	No. 13A
V	Cover support.....	P-235850	P-235850
X	Key panel—Red buttons.....	No. 542A Key	No. 543A Key
Y	Key panel—White buttons....	No. 542B Key	No. 543B Key
Z	Key panel—Black buttons....	No. 541A Key	No. 541A Key
	Cover.....	P-235842	P-235842
	Circuit label.....	P-244443	P-244444

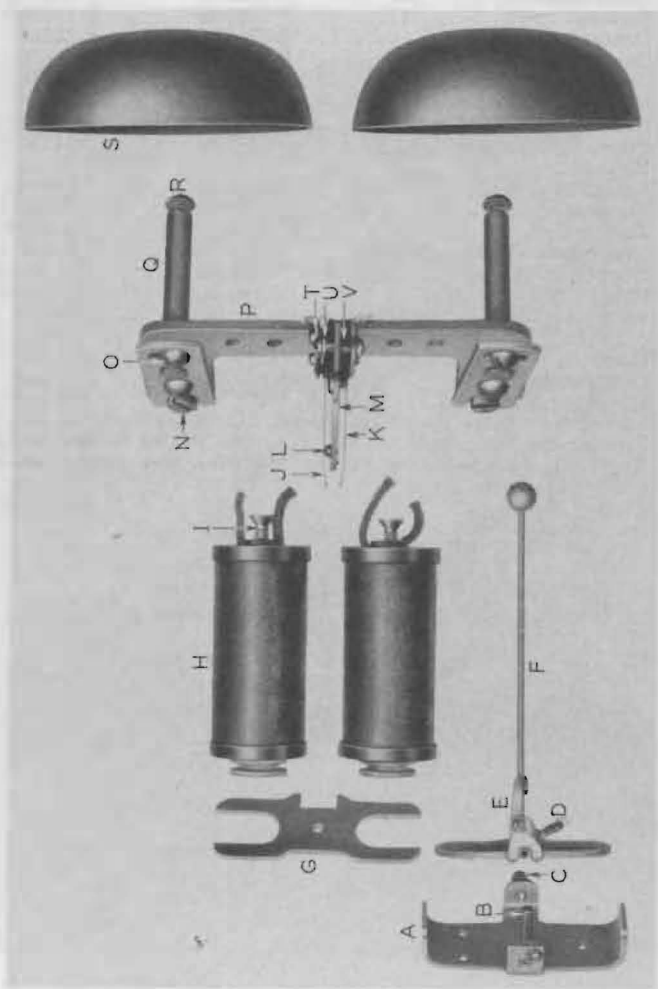


Figure 47—No. 60CG Ringer

<u>No.</u>	<u>Subject</u>	<u>No. 60CG Ringe</u>
A	Armature adjuster.....	P-140855
B	Adjusting screw.....	P-108454
C	{Pivot screw.....	P-101698
	{Set nut.....	P-101699
D	Spring.....	P-140835
E	Contact arm.....	P-145539
F	Clapper and armature.....	P-145541
G	Clamping plate.....	P-140849
H	Coil assembly.....	P-140859
I	Coil mounting screw.....	P-40837
J	Contact spring.....	P-140844
K	Contact spring.....	P-140845
L	Rubber separator.....	P-140848
M	Contact terminal.....	P-140847
N	Eccentric.....	P-101697
O	R.H. machine screw.....	P-112962
P	Heel iron.....	P-140850
Q	Gong post.....	P-205284
R	Gong mounting screw.....	P-107918
S	Gong.....	P-124456
T	{Clamping plate.....	P-140894
	{Pile-up screw.....	P-140862
U	{Terminal.....	P-140852
	{Terminal screw.....	P-92956
V	{Bushing.....	P-140851
	{Insulator.....	P-140857

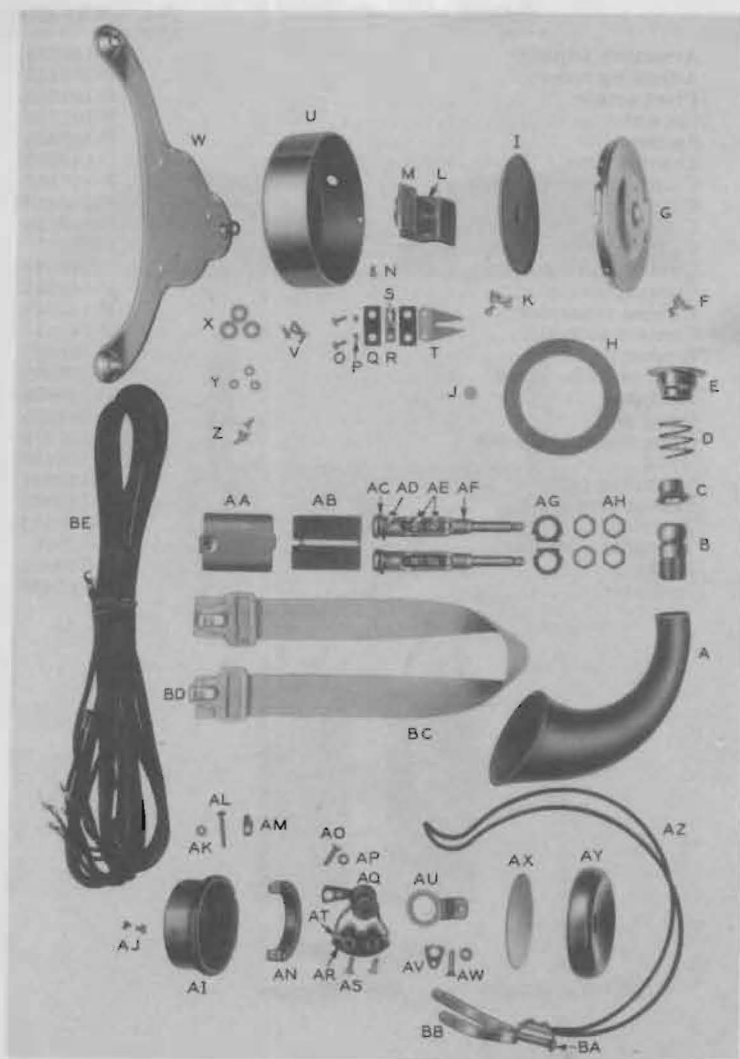


Figure 48—Dispatcher's Head Telephone Set

DISPATCHER HEAD TELEPHONE SET

No.	Subject	No. 386 Transmitter
A	Rubber mouth piece.....	P-91425
B	Mouth piece tip.....	P-91413
C	Friction washer.....	P-93463
D	Spring.....	P-85460
E	Socket.....	P-85458

F	Socket screw	P-98398
G	Face	P-99692
H	Insulating ring	P-97904
I	Diaphragm	P-97905
J	Insulating disc	P-95750
K	Bridge screw	P-98336
L	Granular button	P-99264
M	Bridge and center	P-95782
N	Button mounting screw	P-91810
O	Terminal block screw	P-98334
P	Rubber bushing	P-98335
Q	Phenol fibre insulator	P-99369
R	Terminal block	P-217476
S	Terminal screw	P-129702
T	Damping spring	P-95751
U	Bell	P-93465
V	Face screw	P-99649
W	Breast plate	P-98691
X	Washer	P-106819
Y	Bell nut	P-92609
Z	Bell screw	P-98759

<u>No.</u>	<u>Subject</u>	<u>No. 137 Plug</u>
AA	Shell	P-124076
AB	Body insulator	P-214420
AC	Fibre washer	P-124075
AD	Plug location screw	P-124071
AE	Cord terminal screw	P-82239
AF	Profiling assembly	P-215439
AG	Fibre washer	P-124074
AH	Hexagonal nut	P-81339

<u>No.</u>	<u>Subject</u>	<u>No. 189 Receiver</u>
AI	Case	P-215906
AJ	Coil mounting screw	P-97053
AK	Cord fastener nut	P-92609
AL	Cord fastener screw	P-98975
AM	Cord fastener	P-97065
AN	Magnet	P-97064
AO	Magnet screw	P-97055
AP	Magnet hex. nut	P-132958
AQ	Coil	P-207461
AR	Binding post	P-98974
AS	Binding post screw	P-93540
AT	Terminal	P-97062
AU	Ring pole piece	P-97066
AV	Spacer	P-207457
AW	Pole piece screw	P-97056
AX	Diaphragm	P-95225
AY	Cap	P-94545
AZ	Head band	P-98920
BA	Yoke screw	P-147164
BB	Yoke	P-98796

No. 3B
Head
Band

<u>No.</u>	<u>Subject</u>	<u>No. 3A Transmitter Attachment</u>
BC	Strap	P-85537
BD	Buckle	P-89923

<u>No.</u>	<u>Subject</u>	<u>No. 565 Cord</u>
BE	No. 565 Cord	

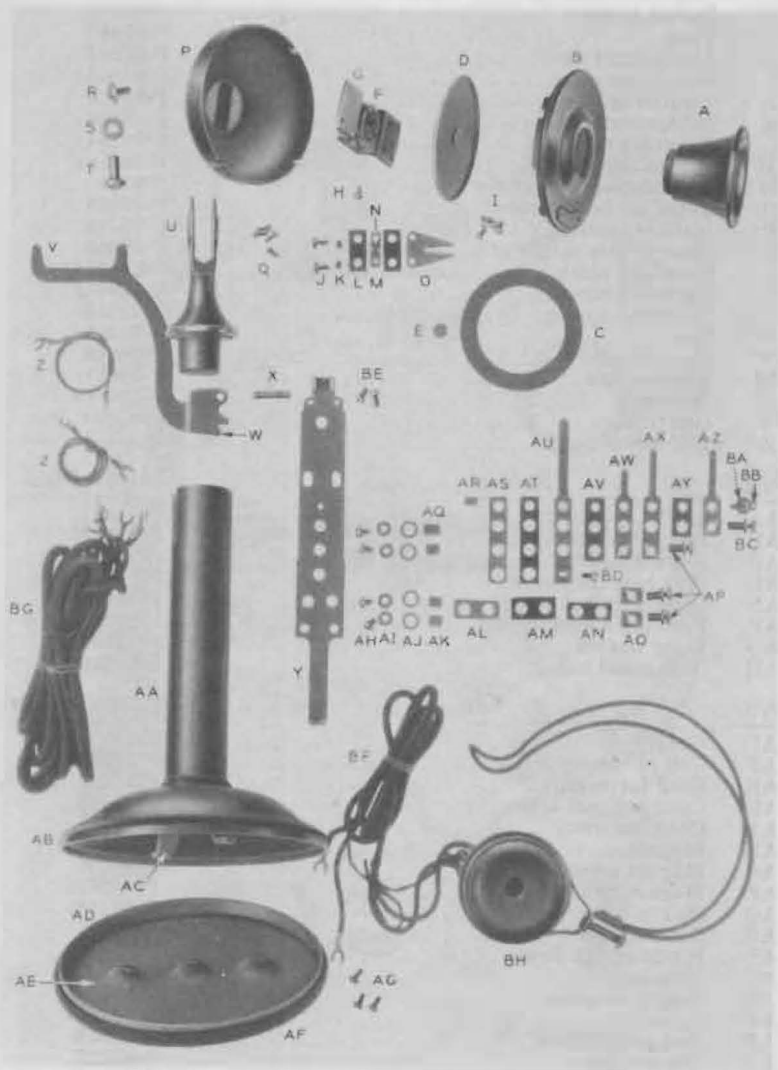


Figure 49—No. 1142AB Desk Stand

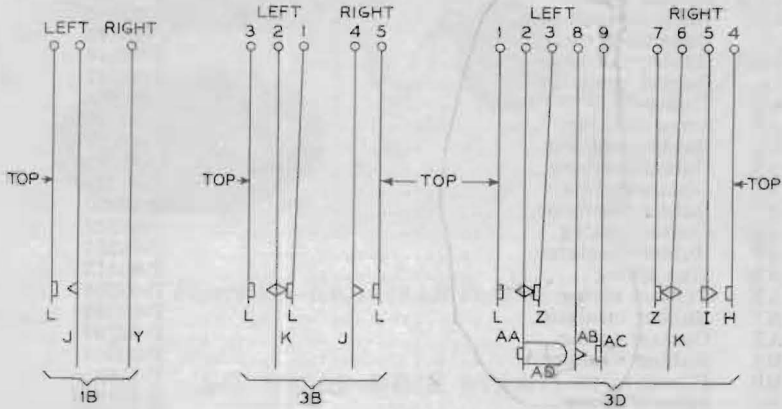
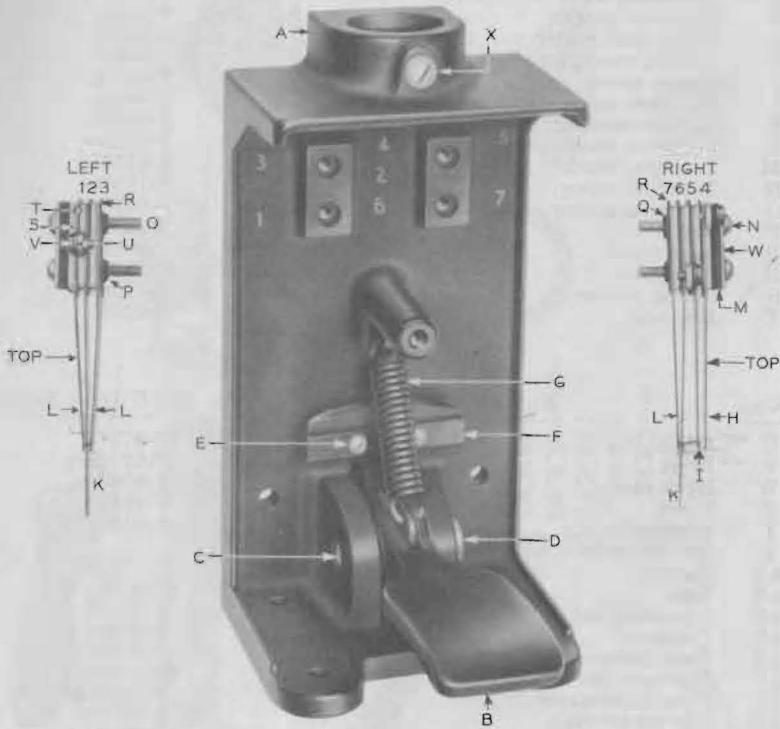
NO. 1142AB DESK STAND

No.	Subject	No. 349 Transmitter
A	Mouthpiece.....	P-247018
B	Face.....	P-207910

C	Insulating ring	P-97904
D	Diaphragm	P-97905
E	Insulating disc	P-95750
F	Granular button	P-99264
G	Bridge and center	P-95782
H	Button mounting screw	P-91810
I	Bridge screw	P-98336
J	Terminal block screw	P-98334
K	Rubber bushing	P-98335
L	Terminal insulator	P-99369
M	Terminal block	P-217476
N	Terminal screw	P-129701
O	Damping spring	P-95751
P	Bell	P-222386
Q	Face screw	P-204520
R	Bell screw	P-92378
S	Spring washer	P-92381
T	Bell bolt	P-92375

<u>No.</u>	<u>Subject</u>	<u>No. 42AB Desk Stand</u>
U	Lug holder	P-97374
V	Hook	P-97348
W	Hook stop	P-93377
X	Pivot	P-92678
Y	Terminal plate	P-94594
Z	No. 427 cord	
AA	Handle	P-97363
AB	Base	P-97351
AC	Clamping nut	P-87530
AD	Clamp	P-87527
AE	Base plate	P-87526
AF	Felt cushion	P-97994
AG	Base plate screw	P-129408
AH	Pile-up screw	P-98092
AI	Steel washer	P-98091
AJ	Rubber washer	P-93354
AK	Rubber bushing	P-93295
AL	Distance piece	P-93345
AM	Rubber insulator	P-93346
AN	Rubber insulator	P-93347
AO	Clamp	P-93348
AP	Screw bushing	P-130262
AQ	Rubber bushing	P-93299
AR	Rubber bushing	P-93291
AS	Distance piece	P-93349
AT	Rubber insulator	P-93350
AU	Contact spring	P-98232
AV	Rubber insulator	P-93351
AW	Stop spring	P-93313
AX	Contact spring	P-98208
AY	Rubber insulator	P-93352
AZ	Contact spring	P-98209
BA	Rubber washer	P-93353
BB	Pile-up screw	P-116855
BC	Screw bushing	P-130263
BD	Contact spring screw	P-128912
BE	Lug holder screw	P-92619
BF	No. R2U cord	
BG	No. D3D cord	
BH	For parts see Figure 55	No. 189 Receiver

NO. 3C FOOT SWITCH



SPRING COMBINATIONS FOR NOS. 1B, 3B AND 3D FOOT SWITCHES

Figure 50—Nos. 1B, 3B, 3C and 3D Foot Switches

FOOT SWITCHES

No.	Subject	No. 1B	No. 3B	No. 3C	No. 3D
A	Case.....	P-94438	P-94438	P-94438	P-94438
B	Pedal.....	P-94440	P-94440	P-94440	P-94440
C	Pivot pin.....	P-94441	P-94441	P-94441	P-94441
D	Pivot pin nut.....	P-94442	P-94442	P-94442	P-94442
E	Pedal screw.....	P-94445	P-94445	P-94445	P-94445
F	Pedal insulator.....	P-94444	P-94444	P-94444	P-94444
G	Pedal spring.....	P-94443	P-94443	P-94443	P-94443
H	Contact spring.....			P-98590	P-98590
I	Contact spring.....			P-98588	P-98588
J	Contact spring.....	P-94460	P-94460		
K	Contact spring.....		P-94461	P-94461	P-94461
L	Contact spring.....	P-94458	P-94458	P-94458	P-94458
M	Top insulator.....	P-94454	P-94454	P-94454	P-94454
N	Pile-up screw.....	P-94467	P-94448	P-94448	P-94448
O	Pile-up screw.....	P-94448	P-94448	P-94448	P-209711
P	Left bushing.....	P-94449	P-94449	P-94449	P-209714
Q	Right bushing.....	P-94463	P-94449	P-133268	P-133268
R	Spring insulator.....	P-94453	P-94453	P-94453	P-94453
S	Terminal.....	P-94451	P-94451	P-94451	P-94451
T	Terminal.....		P-94452	P-94452	P-94452
U	Terminal washer.....	P-103706	P-103706	P-103706	P-103706
V	Terminal screw.....	P-128912	P-128912	P-128912	P-128912
W	Clamp plate.....	P-94450	P-94450	P-94450	P-94450
X	Locking screw.....	P-94447	P-94447	P-94447	P-94447
Y	Contact spring.....	P-94462			
Z	Contact spring.....				P-94458
AA	Contact spring.....				P-209716
AB	Contact spring.....				P-209713
AC	Contact spring.....				P-209712
AD	Separator.....				P-209715
	Cover screw.....	P-94446	P-94446	P-94446	P-94446
	Cover.....	P-94439	P-94439	P-94439	P-94439
	Complete left Spring assembly			P-290256	P-290279
	Complete Right Spring assembly			P-290257	P-290280

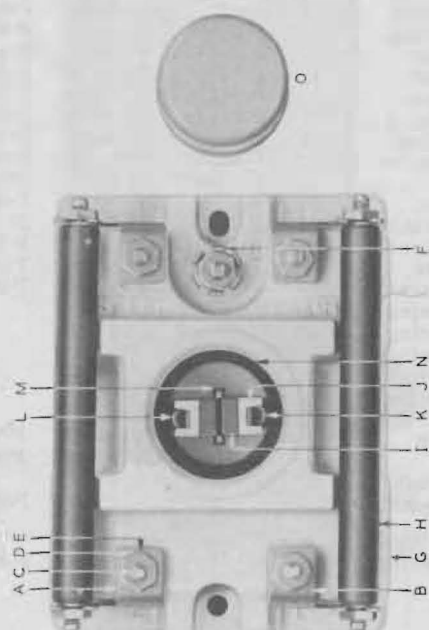


Figure 51—No. 98B Protector

<u>No.</u>	<u>Subject</u>	<u>98B Protector</u>
A	Terminal clip.....	P-375392
B	Terminal clip.....	P-375393
C	Binding post.....	P-375354
D	Hexagon nut.....	P-234966
E	Washer.....	P-234967
F	Pronged washer.....	P-375290
G	Base.....	P-375531
H	11-C Fuse.....	
I	No. 26 Protector Block.....	
J	No. 30 Protector Block.....	
K	Spring.....	P-375530
L	Spring.....	P-375529
M	Terminal.....	P-375359
N	Gasket.....	P-375254
O	Cap.....	P-375462

Graybar
ELECTRIC COMPANY

San Antonio
San Diego
San Francisco
Savannah
Seattle
Spokane
Springfield
Syracuse
Tacoma
Tampa
Toledo
Washington
Wichita
Winston-Salem
Worcester
Youngstown

[100]

