TELEPHONE DIAGRAMS.

52

772

A W J Latimer
Central Telephone
Exchange
Lonsdale St
Melbourne
1 - 1 - 26

4
5

TELEPHONE DIAGRAM BOOK - ERRATA.

Diagram No. 14 - Wall Set.

Present terminals are incorrectly numbered -

Terminal "No. 4" should be "No. 3"
Terminal "No. 3" should be "No. 1"
and the unnumbered terminal should be "Terminal No. 4"

Diagram No. 112.

Erase the word "Murray" as applied to the fourth diagram and substitute "Varley".

COMMONWEALTH OF AUSTRALIA.

POSTMASTER-GENERAL'S DEPARTMENT.

CONNECTIONS

OF

TELEPHONIC APPARATUS

AND

CIRCUITS

(Exclusive of Multiple Switchboard Circuits and Apparatus).

POSTMASTER-GENERAL'S DEPARTMENT,
MELBOURNE.
1914.

Price Three Shillings. C.6133.—B

NOTE.

For purposes of economy the majority of the diagrams included in this book have been copied from existing drawings prepared and used in the different States prior to the adoption of standard conventions. It has not, therefore, been possible to adhere throughout to the conventional signs for diagrams shown on Diagram No. 103.

List of Telephones, Switches, and Switchboards.

WALL TELEPHONES.

PRESENT TITLE.	PREVIOUS TITLE.
Telephone—	
No. 1.	Telephone, Magneto, Wall, Commonwealth Type.
„ 3.	„ „ „ Ericsson, Type A.
„ 5.	„ „ „ Bridging Type (B.I.H. Co.).
„ 7.	„ „ „ Bridging Type, (Hunning's Cone).
„ 9.	„ „ „ Bridging Type (Delville).
„ 11.	„ „ „ „ „ (W. E. Delville).
„ 13.	„ „ „ Non-bridging Type (Hunning's Cone.)
„ 15.	„ Common Battery, Wall (W.E. Type).
„ 17.	„ „ „ „ (B.I. Type).
„ 19.	„ „ „ „ (G.E. Type).
„ 21.	„ „ „ „ (Ericsson Type).
„ 23.	„ „ „ „ Party Line (Ericsson Type).
„ 25.	„ Common Battery, Wall, Two Party Line.
„ 27.	„ „ „ „ Main Set and Extension Switch (W.E. Type).
„ 29.	„ Common Battery, Wall, Extension Set, with Generator (W.E. Type).
„ 31.	„ Automatic, Wall (Geelong).
„ 33.	„ „ „ with Control Lock (Automatic Electric Coy. Type).
„ 35.	„ Automatic, Wall, Party Line (Geelong).
„ 37.	„ Condenser (Ericsson Type).
„ 39.	„ „ Buzzer.
„ 41.	„ Closed Circuit Buzzer.
„ 43.	„ Open Circuit Buzzer.
„ 45.	„ Phonopore.

NOTE.—Odd numbers have been allotted to Wall Telephones and Even numbers to Table Telephones.

TABLE TELEPHONES.

PRESENT TITLE.	PREVIOUS TITLE.
Telephone—	
No. 2.	Telephone, Magneto, Table, Commonwealth Type.
„ 4.	„ „ „ Bridging Type (Ericsson).
„ 6.	„ Common Battery, Table, Series with Electro-magnetic Receiver (G.E. Type).
„ 8.	„ Common Battery, Table, (Ericsson Type).
„ 10.	„ „ „ „ „ „
„ 12.	„ „ „ „ (B.I. Type).
„ 14.	„ „ „ „ (W.E. Type).

NOTE.—Odd numbers have been allotted to Wall Telephones and Even numbers to Table Telephones.

SWITCHES.

PRESENT TITLE.	PREVIOUS TITLE.
Switch—	
No. 1.	Switch, Magneto, Intermediate (Ericsson Type).
„ 2.	„ „ „ (Capstan Type).
„ 3.	„ Common Battery, Single Extension and Intercommunication, with Visual Signal (Commonwealth Type).
„ 4.	„ Common Battery, Intermediate (B.I. Type).
„ 5.	„ „ „ „ (B.I. T823 Type).
„ 6.	„ Common Battery, Single Extension and Intercommunication, with Visual Signal (Ericsson Type).
„ 7.	„ Common Battery, Intermediate, with Press Buttons (W.E. Type).

CORDLESS SWITCHBOARDS.

PRESENT TITLE.	PREVIOUS TITLE.
Switchboard—	
No. 1.	Switchboard, Cordless, Magneto, P.B. Exchge., four lines (Ericsson Type).
„ 3.	„ „ Magneto, P.B. Exchge., ten lines (W.E. Type).
„ 5.	„ „ Common Battery, P.B. Exchge. (Ericsson Type).
„ 7.	„ „ Common Battery, P.B. Exchge., four lines (W.E. Type).
„ 9.	„ „ Common Battery, P.B. Exchge., four lines (B.I. Type).

CORD SWITCHBOARDS.

PRESENT TITLE.	PREVIOUS TITLE.
Switchboard—	
No. 2.	Switchboard, Cord, Magneto, P.B. Exchge. (B.I. Type).
„ 4.	„ „ „ „ „ (Ericsson Type).
„ 6.	„ „ „ „ „ (W.E. Type).
„ 8.	„ „ „ „ „ 50 or 100 lines (W.E. Floor Pattern).
„ 10.	„ „ „ Non-multiple, B Position.
„ 12.	„ „ Common Battery, P.B. Exchge. (Commonwealth Type).
„ 14.	„ „ „ Battery, P.B. Exchge. (B.I. Type).
„ 16.	„ „ „ „ P.B. Exchge. (Ericsson Type).
„ 18.	„ „ „ „ P.B. Exchge., with Eyeball Indicator (W.E. Type).
„ 20.	„ „ Common Battery P.B. Exchge., with Drop Indicator (W.E. Type).

NOTE.—Odd numbers have been allotted to Cordless Switchboards and Even numbers to Switchboards of the Cord type.

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NOTE.—See List of Telephones for Previous Titles of Telephones.

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NOTE.—See List of Telephones for Previous Titles of Telephones.

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NOTE.—See List of Switches for Previous Titles of Switches.

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NOTE.—See List of Switchboards for Previous Titles of Switchboards.

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Part I.—Telephones.

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Wall Telephones—Magneto, Common Battery, and Automatic.

COMMONWEALTH

MW.1

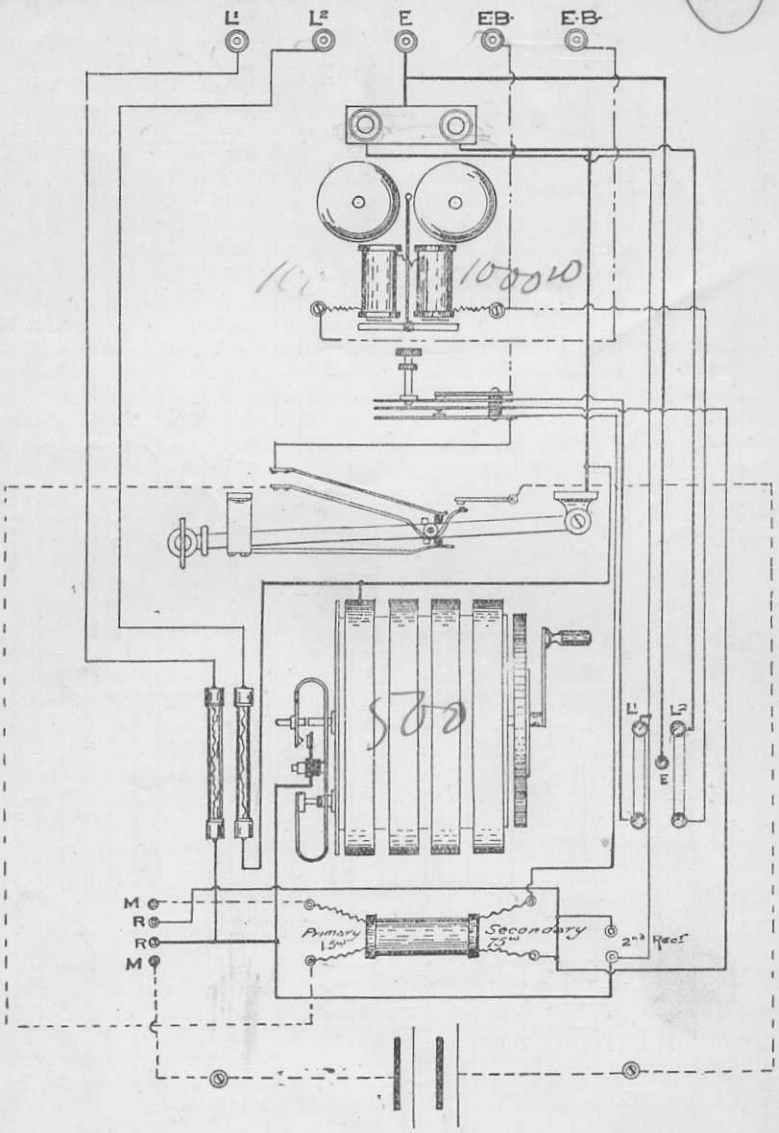


Diagram 1.

Rec 120

Trans 60

COMMONWEALTH M.W.1
FITTED WITH CONDENSER FOR
C.B SERVICE

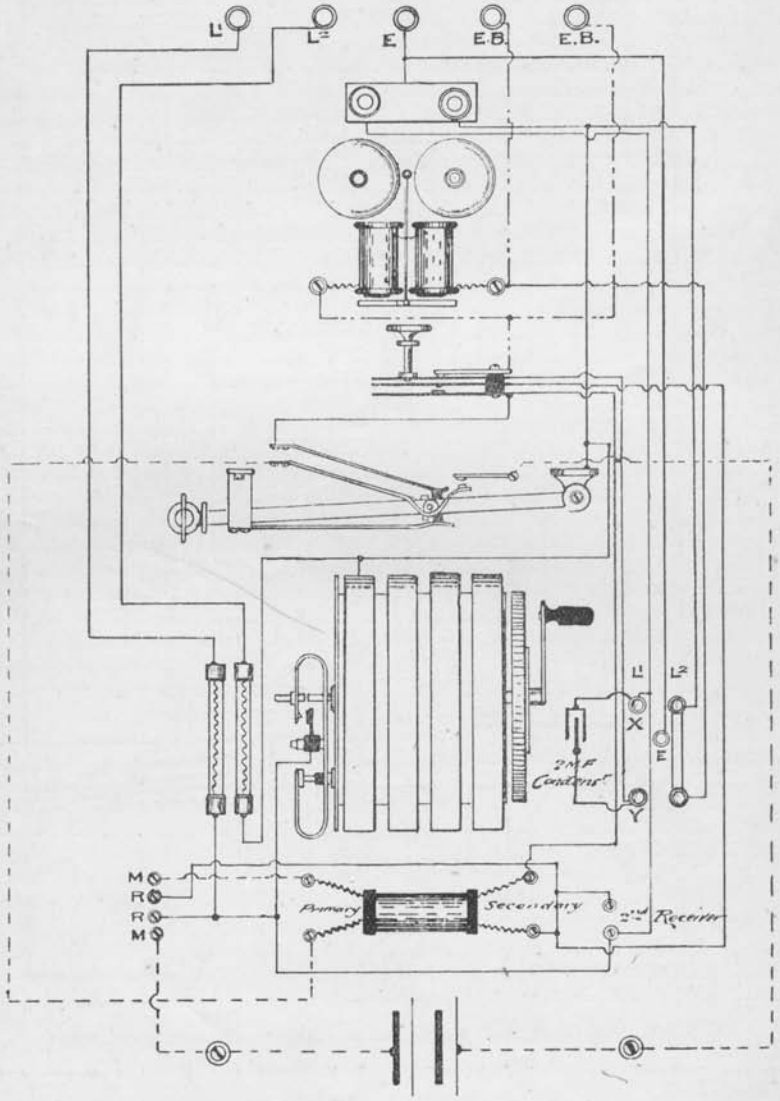
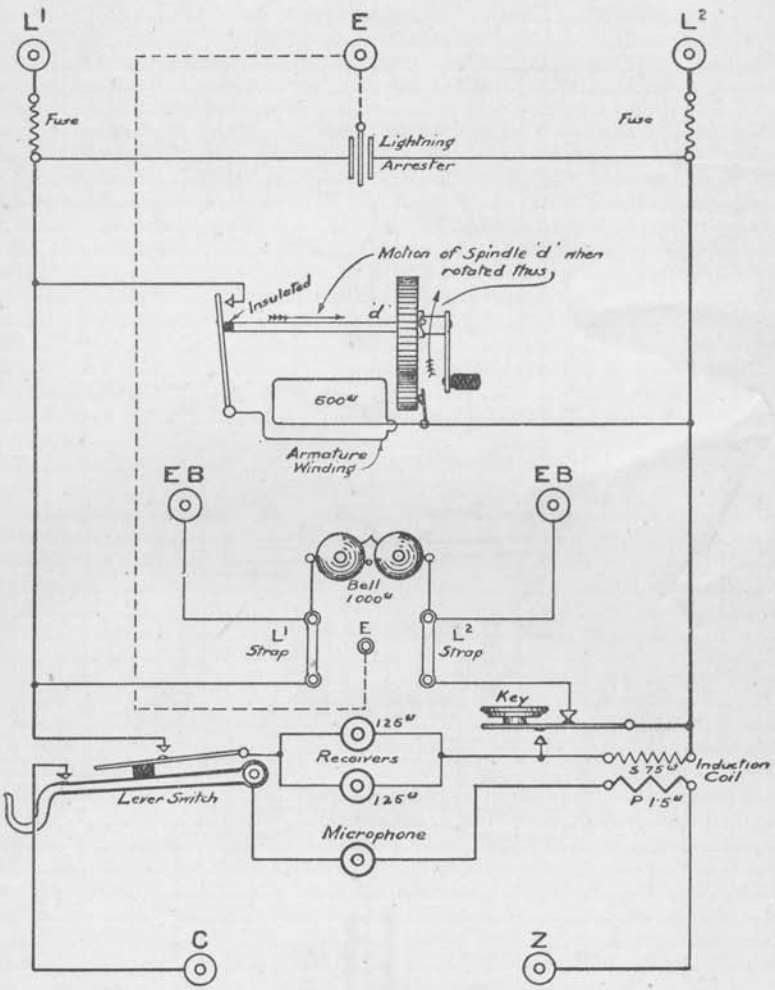


Diagram 2.

COMMONWEALTH M.W.I

SCHEMATIC



When Generator is idle circuit from L1 to L2 through Armature Winding is open.

Diagram 3.

ERICSSON M.W.1
TYPE. A

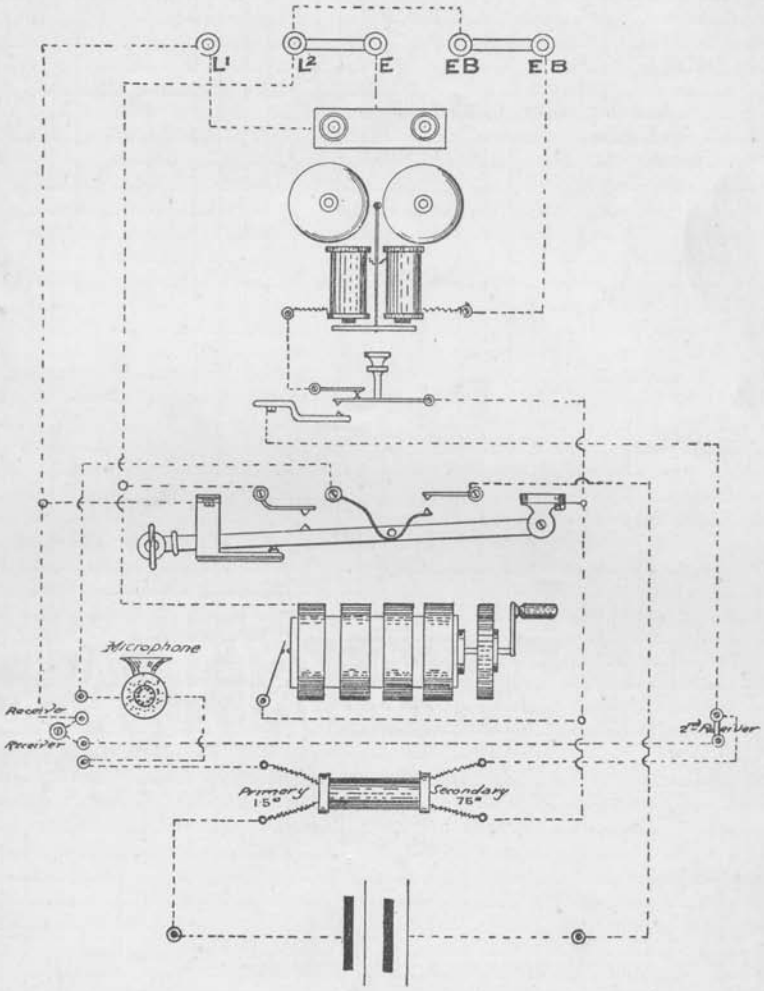


Diagram 4.

ERICSSON M.W.1

FITTED WITH CONDENSER
FOR C.B SERVICE WITHOUT EXTENSION BELL

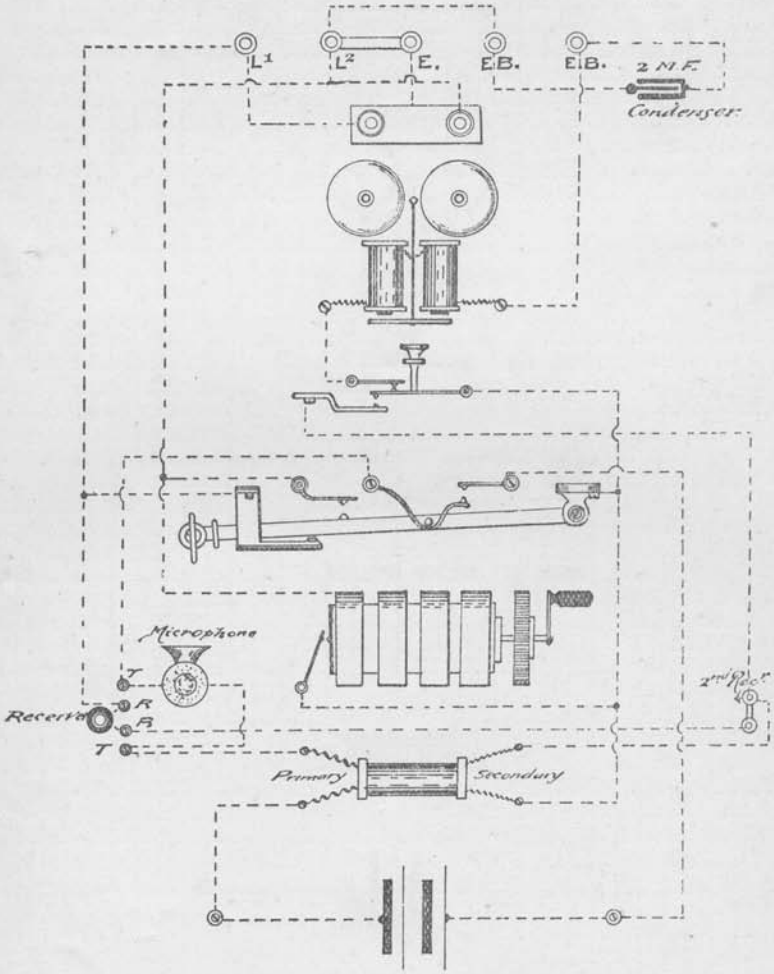


Diagram 5.

ERICSSON M.W.C
FITTED WITH CONDENSER FOR
C-B SERVICE WITH EXTENSION BELL

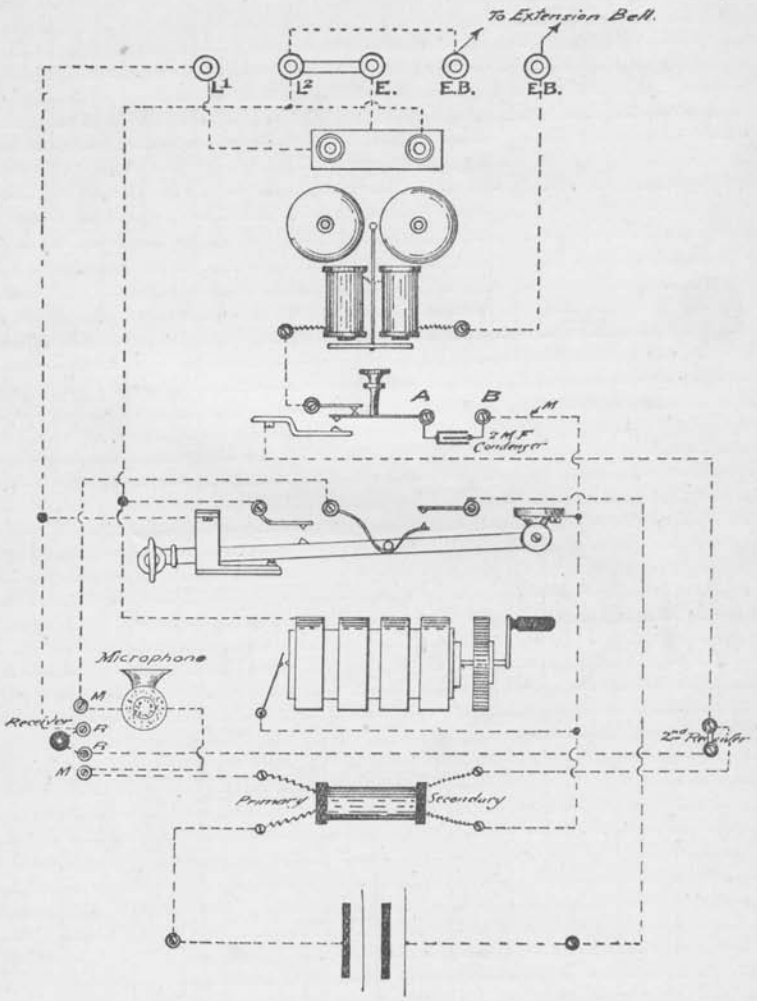
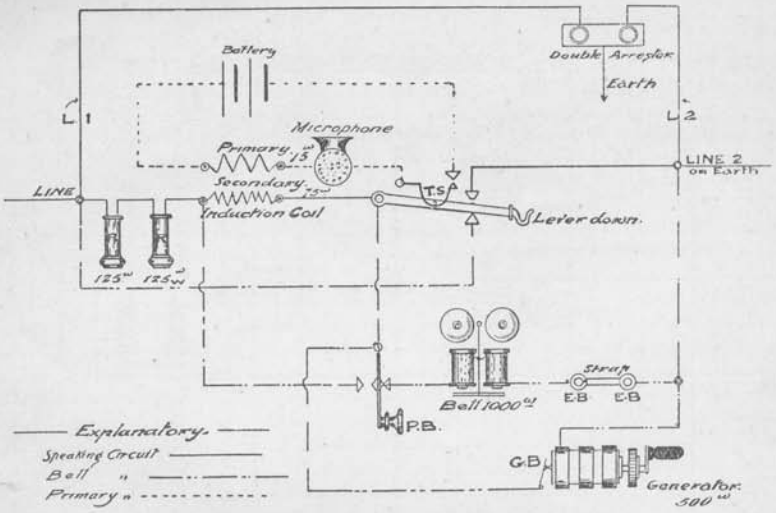


Diagram 6.

Theory of connections-Bell on.



Theory of connections. "Speaking."

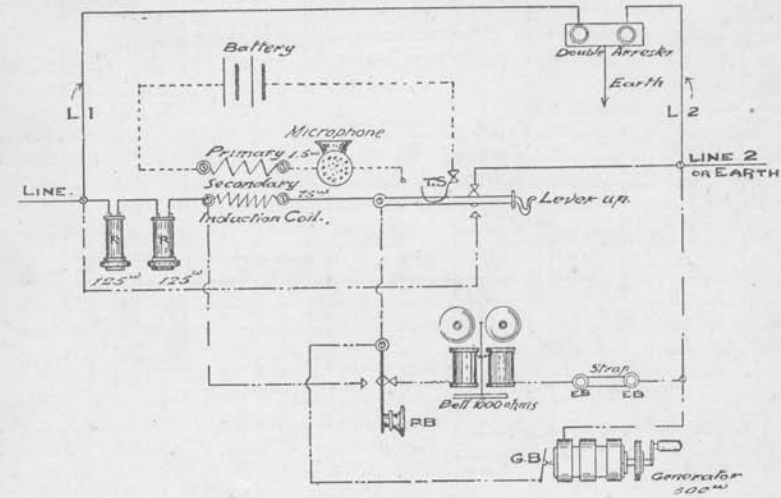
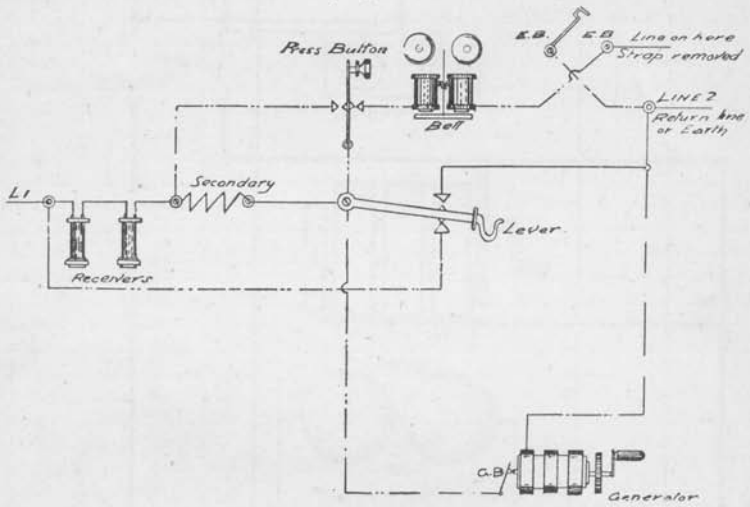
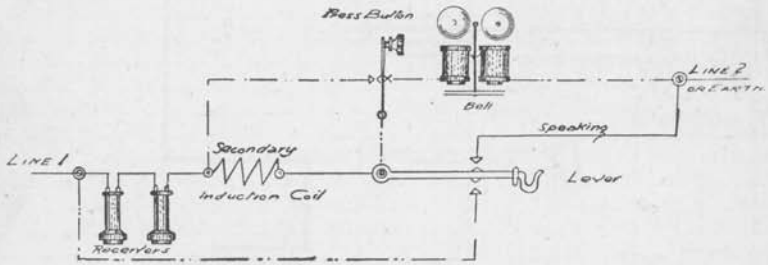


Diagram 7.

Connections for ringing, test of line



Simple diagram of circuits. Microphone circuit omitted.



Explanatory

Speaking Circuit

Bell

Diagram 8.

BRIDGING TYPE
B.I.H & CO.

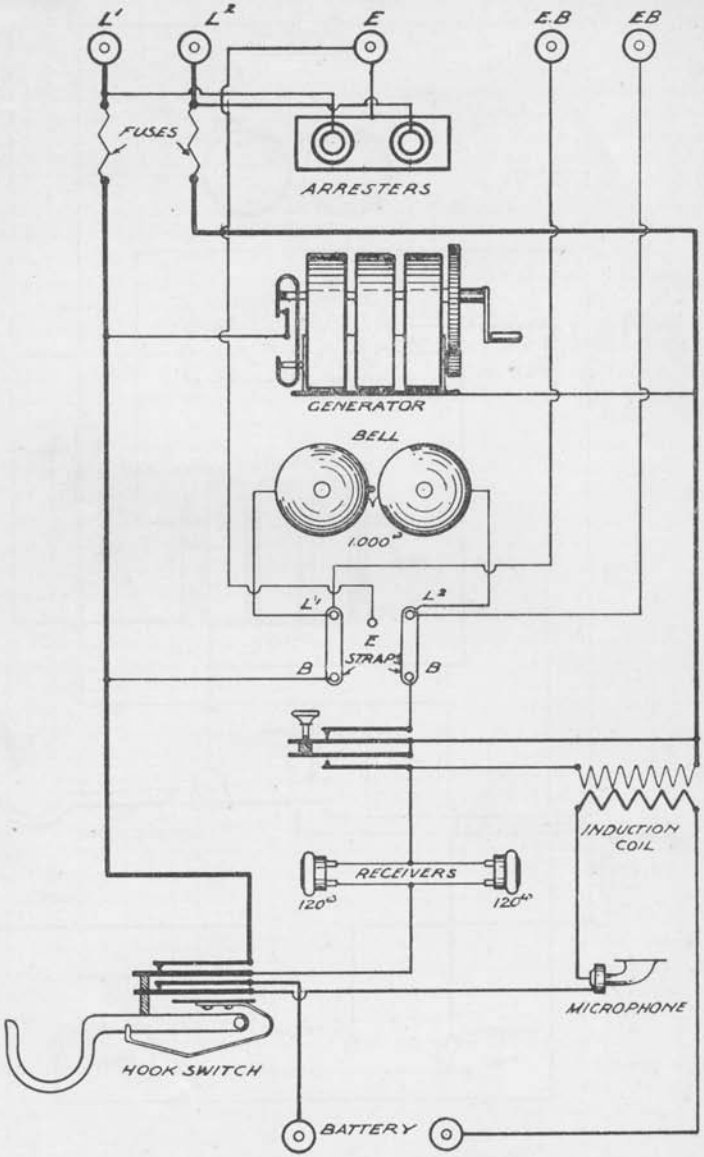


Diagram 9.

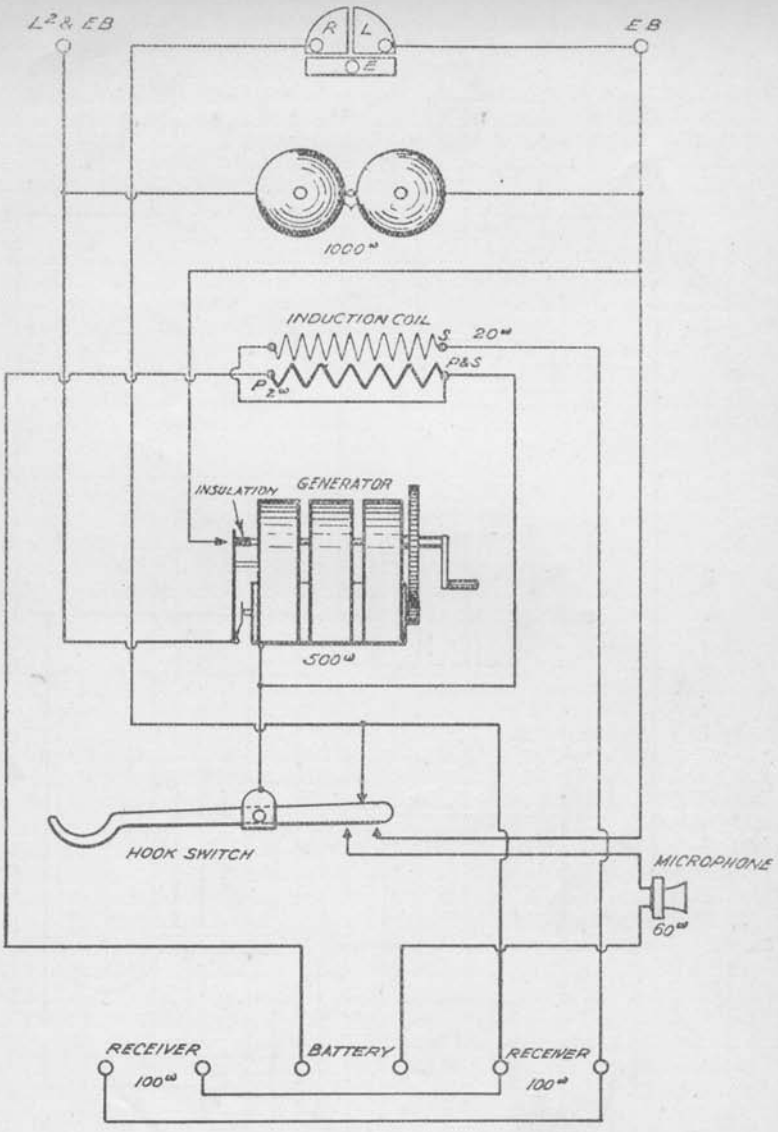

HUNNINGS.
BRIDGING TYPE
L2 & EB
R
L
Z
EB
1000 Ω
INDUCTION COIL
S
20 Ω
P&S
P2 Ω
INSULATION
GENERATOR
500 Ω
HOOK SWITCH
MICROPHONE
50 Ω
RECEIVER
100 Ω
BATTERY
RECEIVER
100 Ω

Diagram 10.

BRIDGING TYPE
FITTED FOR P.T.

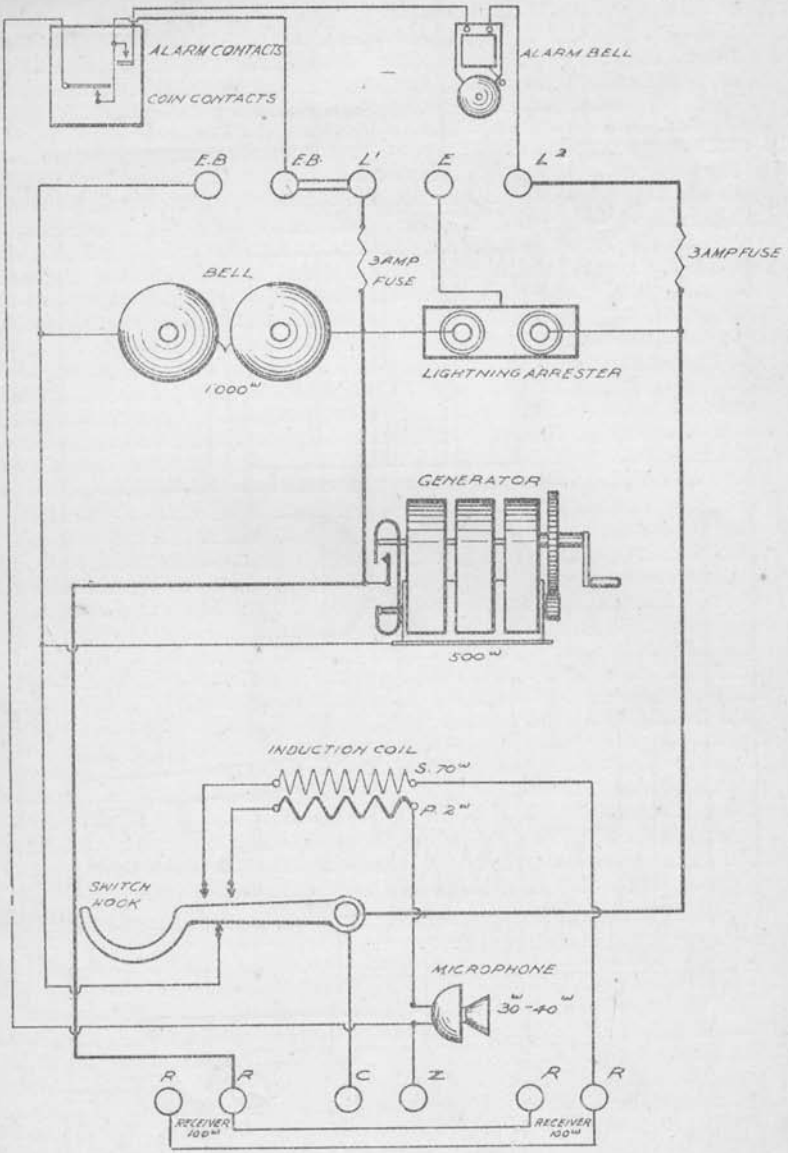


Diagram 11.

M.W.
W.E

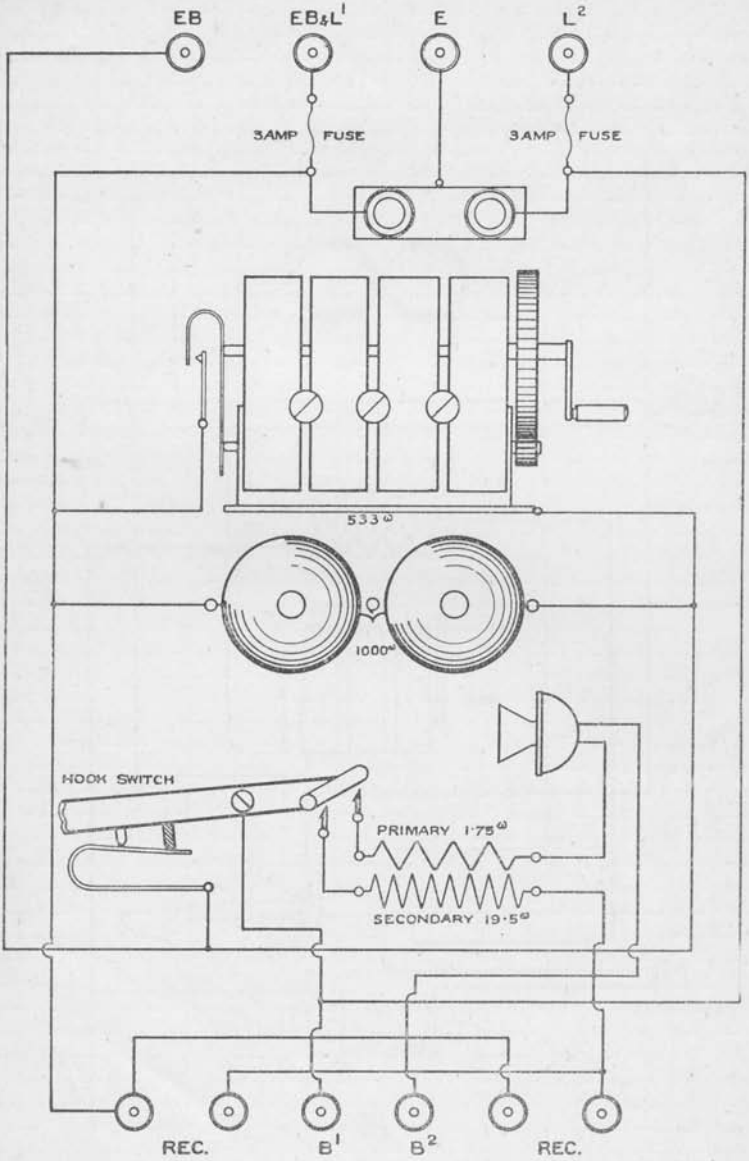


Diagram 12.

HUNNINGS
NON BRIDGING

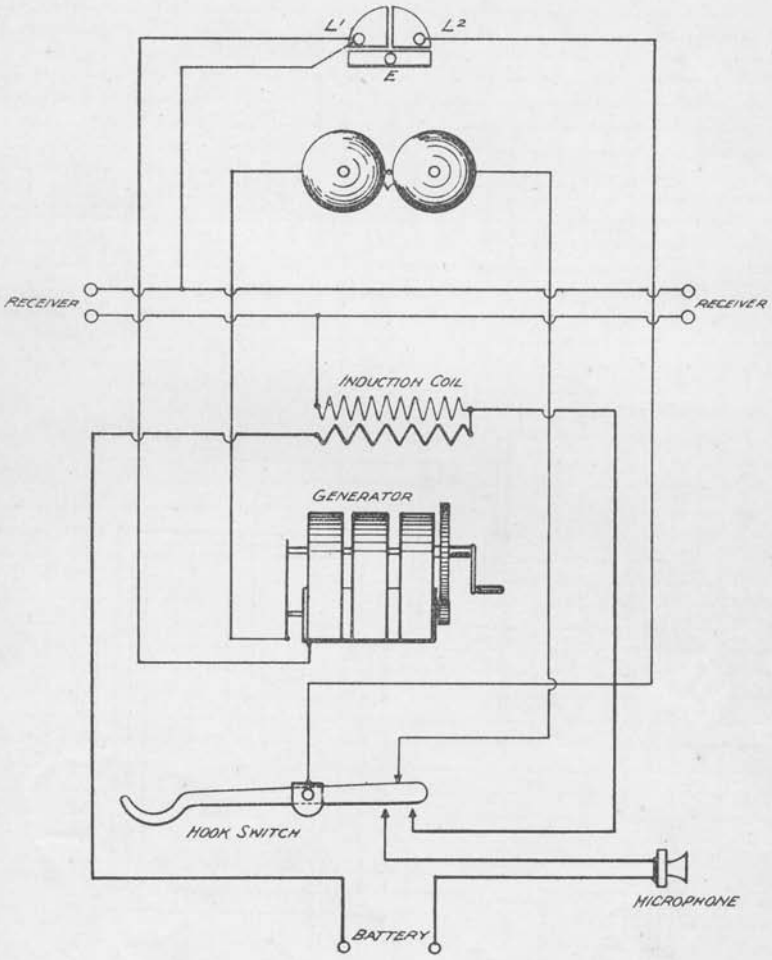
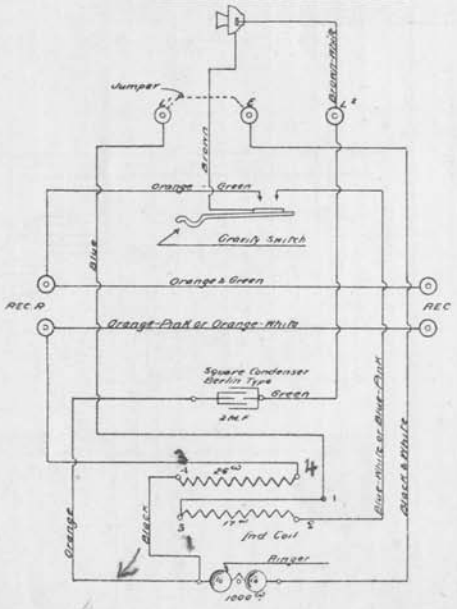


Diagram 13.

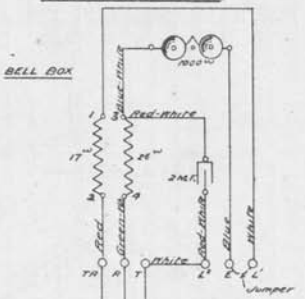
COMMON BATTERY
W. E.

WALL SET (2392A)



SEE NOTE IN FRONT

TABLE SET



N.B. When Extension Bell installed, remove Jumper and connect between L' and E

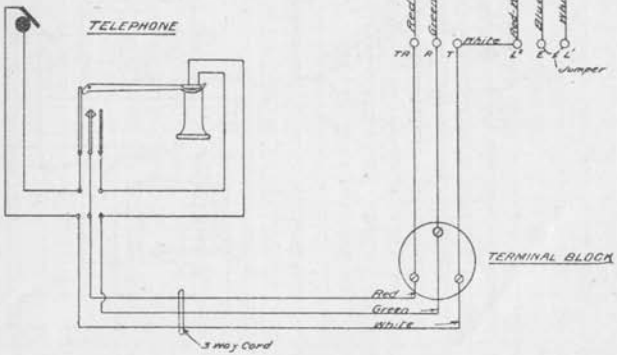


Diagram 14.

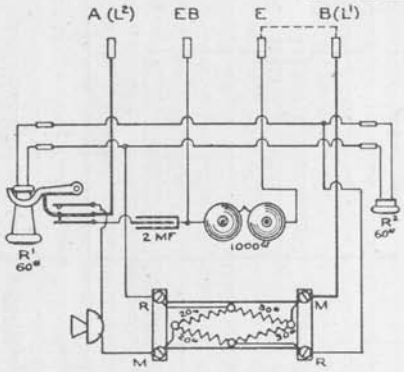
COMMON BATTERY

B·1

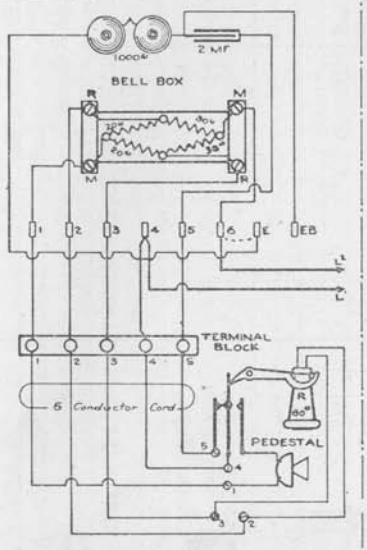
WALL SET.

TABLE SET.

WIRING DIAGRAMS.



NB. When Extension Bell is installed, remove Jumper and connect between E & B. The EB Terminal must not be used.



THEORY OF CONNECTIONS.

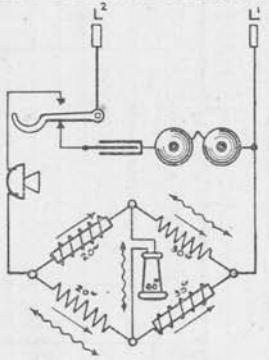
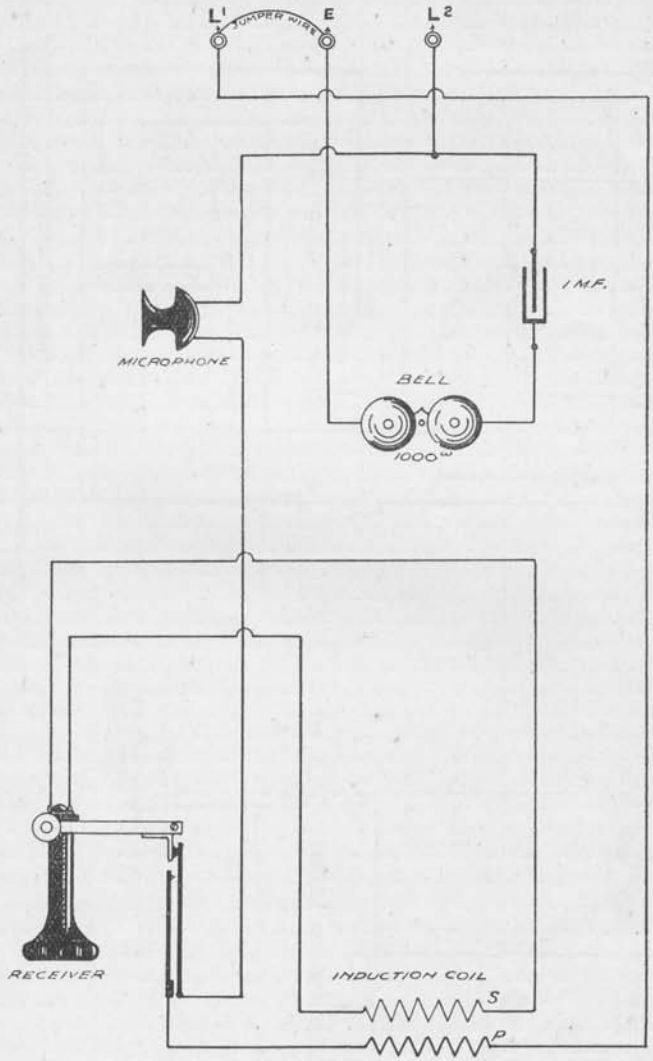


Diagram 15.

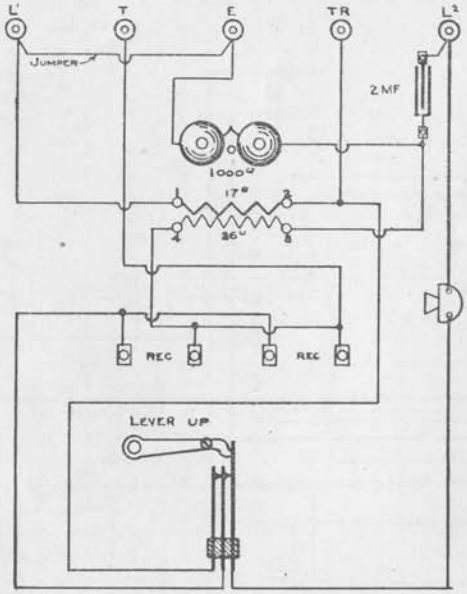
COMMON BATTERY
G·E TYPE



NOTE: WHEN EXTENSION BELL IS INSTALLED, REMOVE JUMPER AND CONNECT BETWEEN L' AND E.

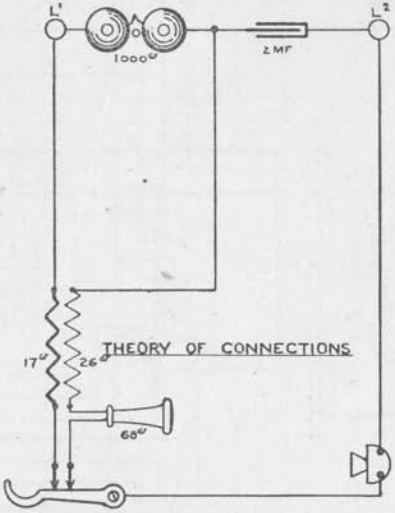
Diagram 16.

COMMON BATTERY
ERICSSON TYPE



WIRING DIAGRAM

When Extension Bell is installed, remove jumper and connect between L & E



N.B This arrangement is exactly similar to W.E Coy's Instruments.

Diagram 17.

COMMON BATTERY
ERICSSON PARTY
LINE

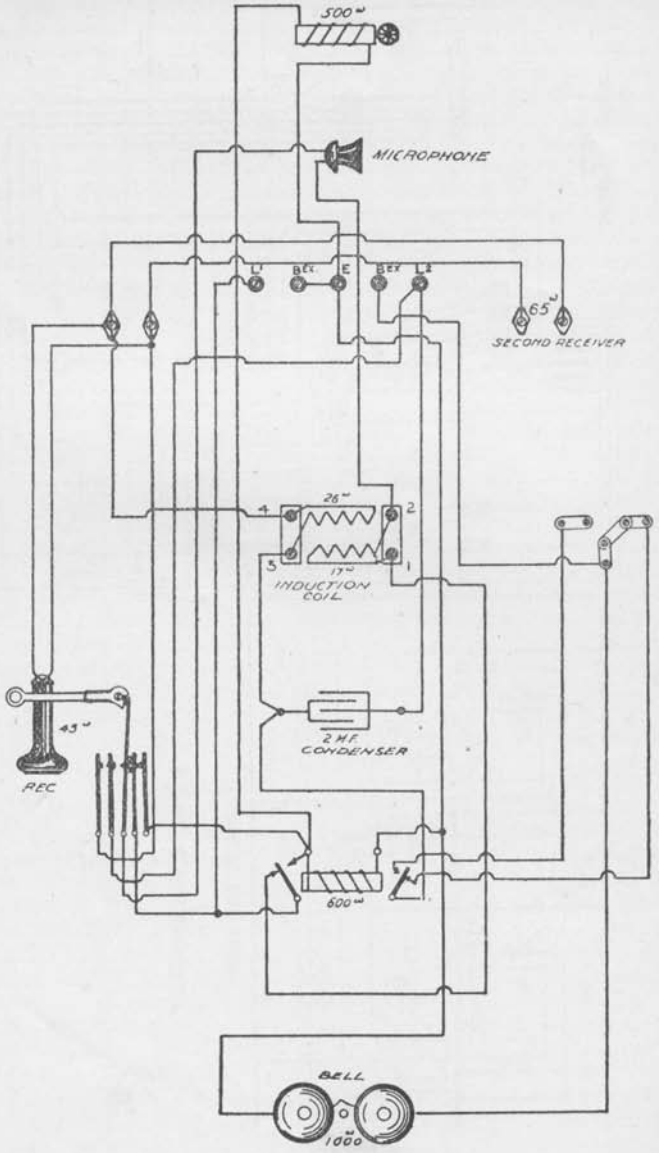
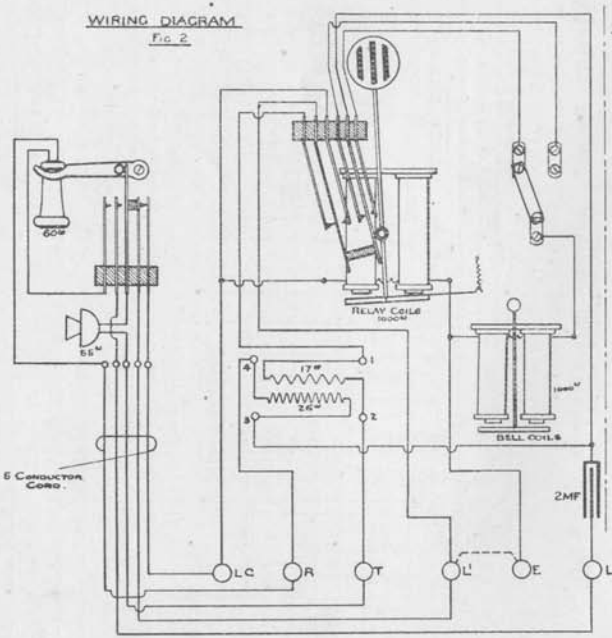
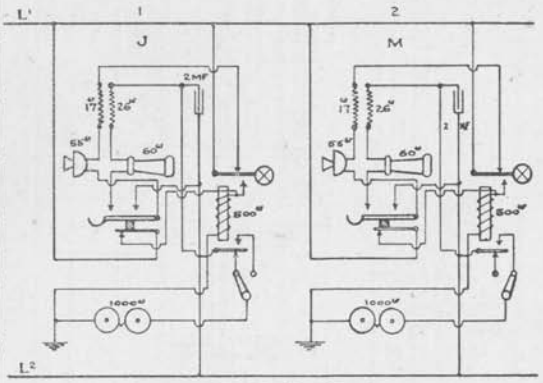


Diagram 18.

COMMON BATTERY WALL 2 PARTY LINE





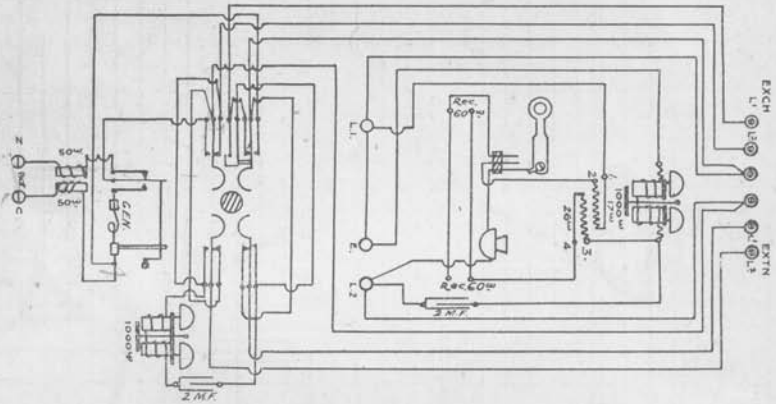
THEORY OF CONNECTIONS
Fig 1

TWO PARTY LINE.

Diagram 19.

COMMON BATTERY
MAIN SET & EXTENSION SWITCH
W.E. TYPE

— MAIN SET —



W.E — EXTENSION SET — WITH GENERATOR

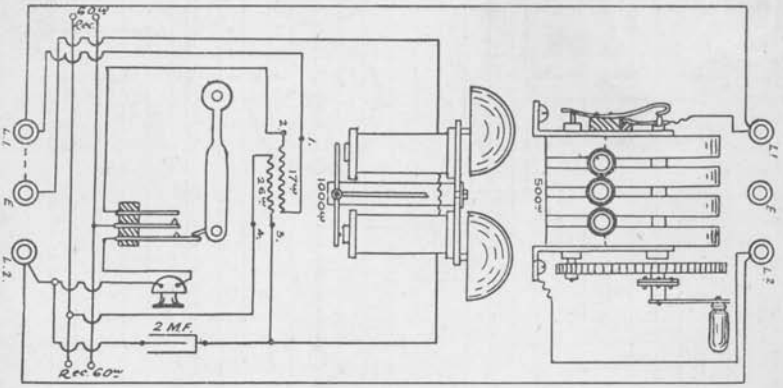


Diagram 20.

AUTOMATIC WALL
GEELONG

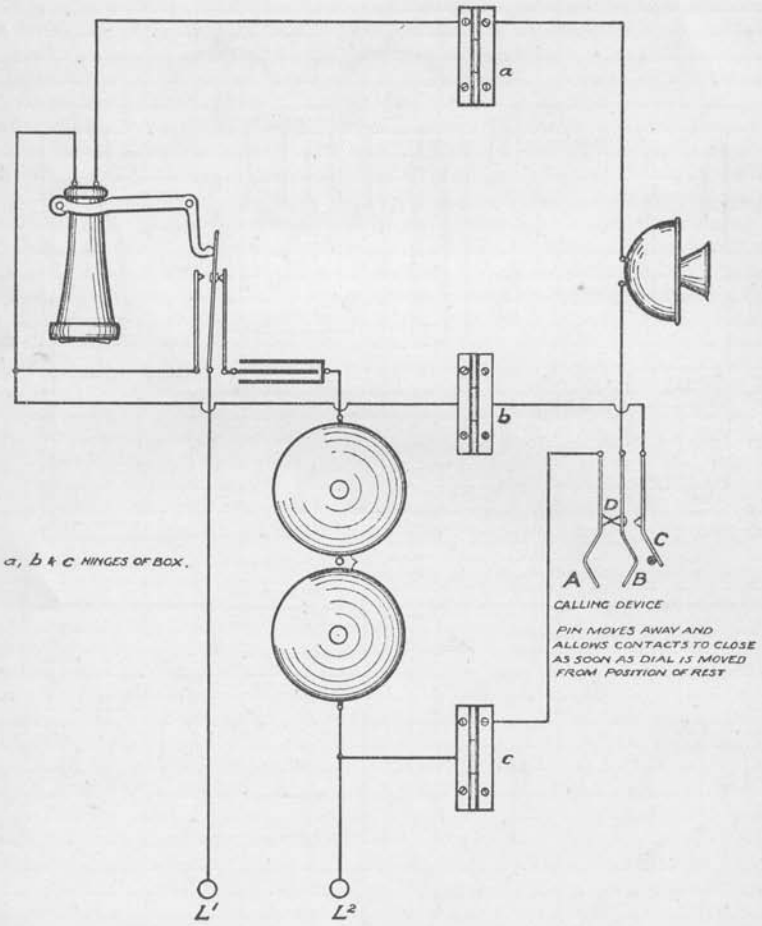
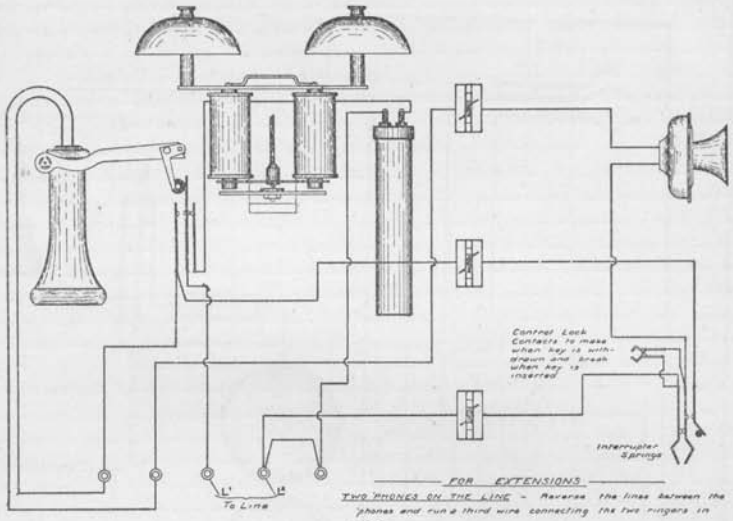


Diagram 21.

AUTOMATIC WALL WITH CONTROL LOCK
AUTOMATIC ELECTRIC COYS TYPE



FOR EXTENSIONS

TWO PHONES ON THE LINE – Reverse the lines between the 'phones and run a third wire connecting the two ringers in series

MORE THAN TWO PHONES ON THE LINE – Bias the ringers and connect them across the line, so that the operating impulses have no effect on them. Determine the right arrangement by test

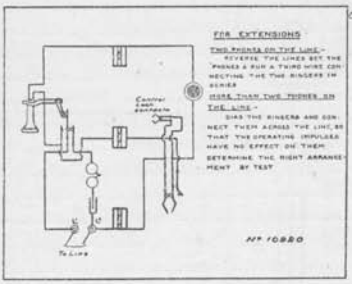


Diagram 22.

AUTOMATIC W/ALL PARTY LINE
GEELONG

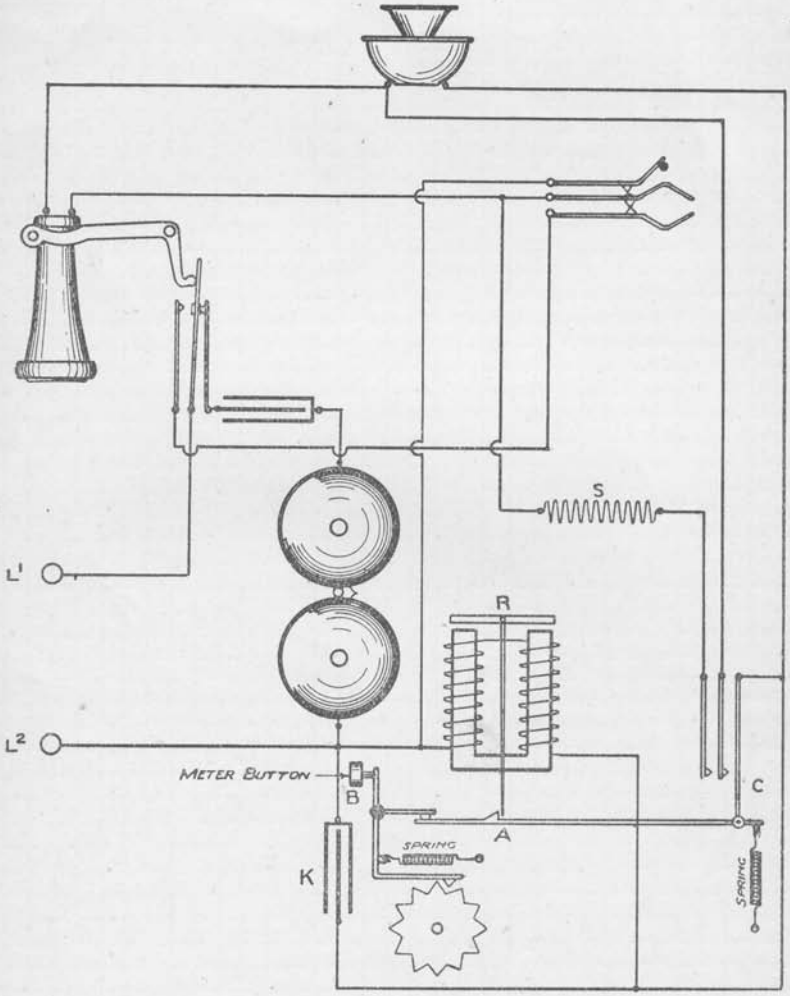
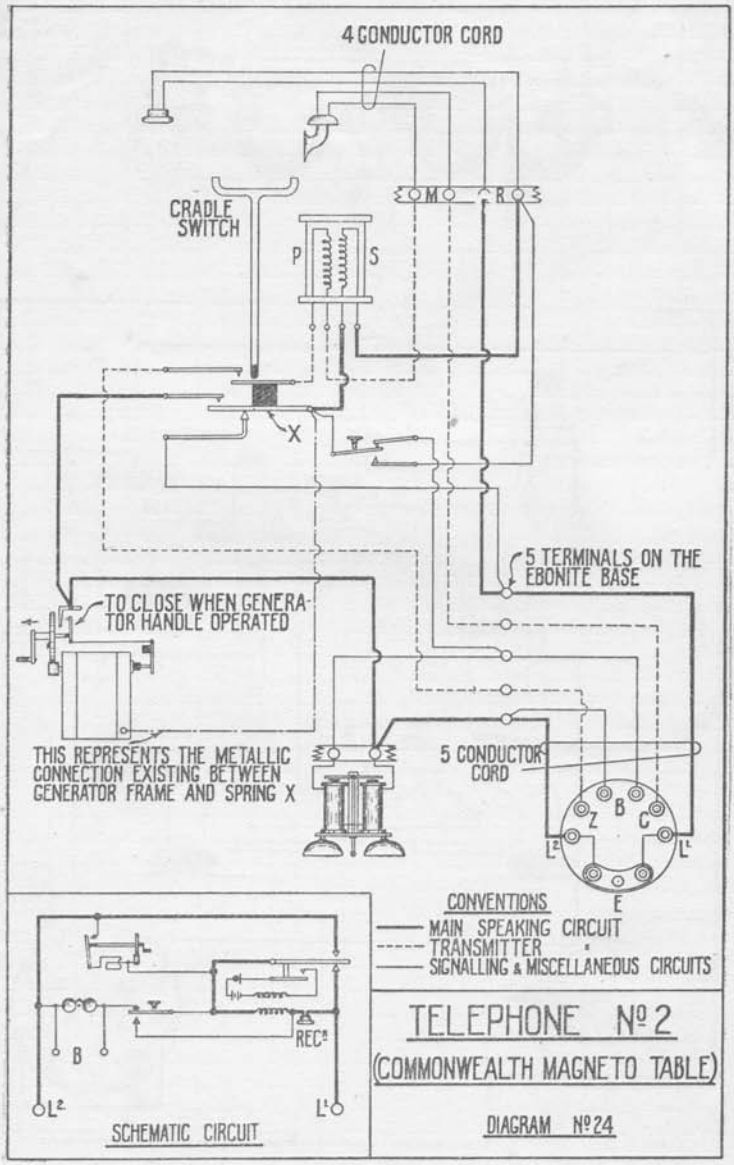


Diagram 23.

SECTION 2.

Table Telephones—Magneto and Common Battery.



Amendment No. 1. Issued 13/12/16.

Diagram 24.

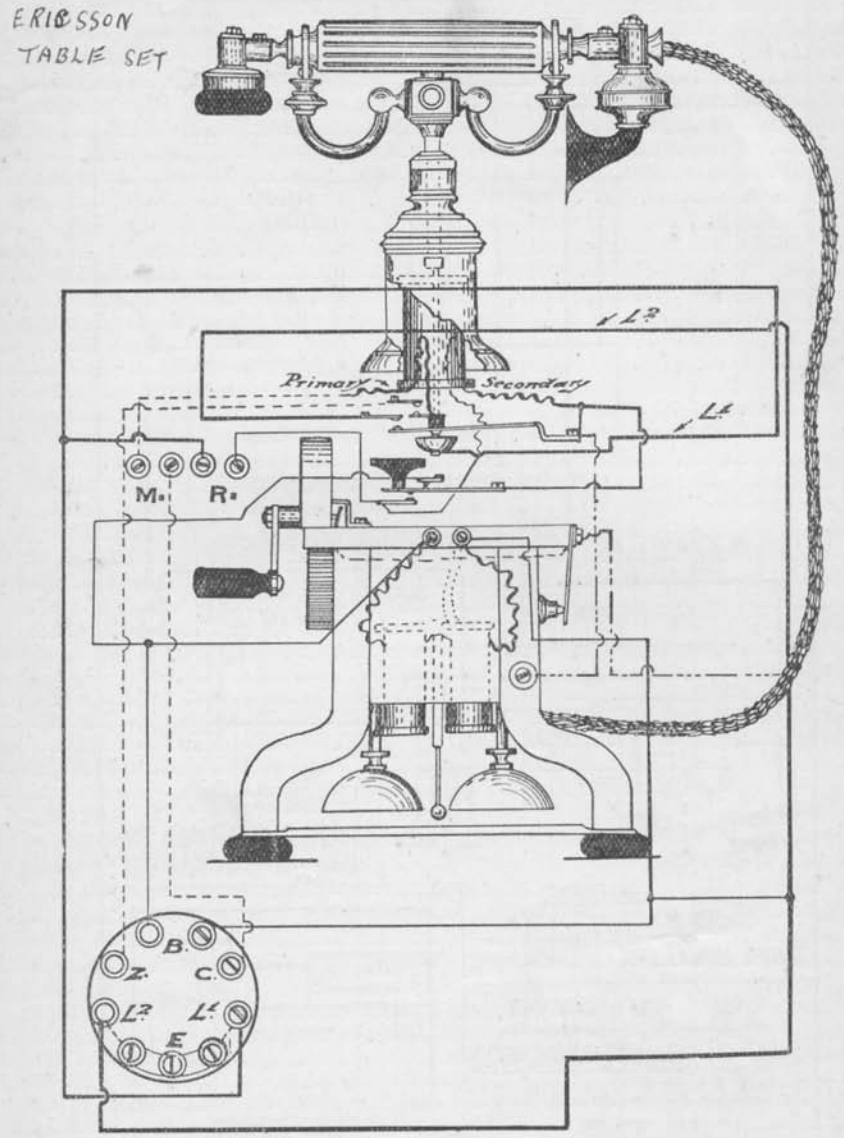
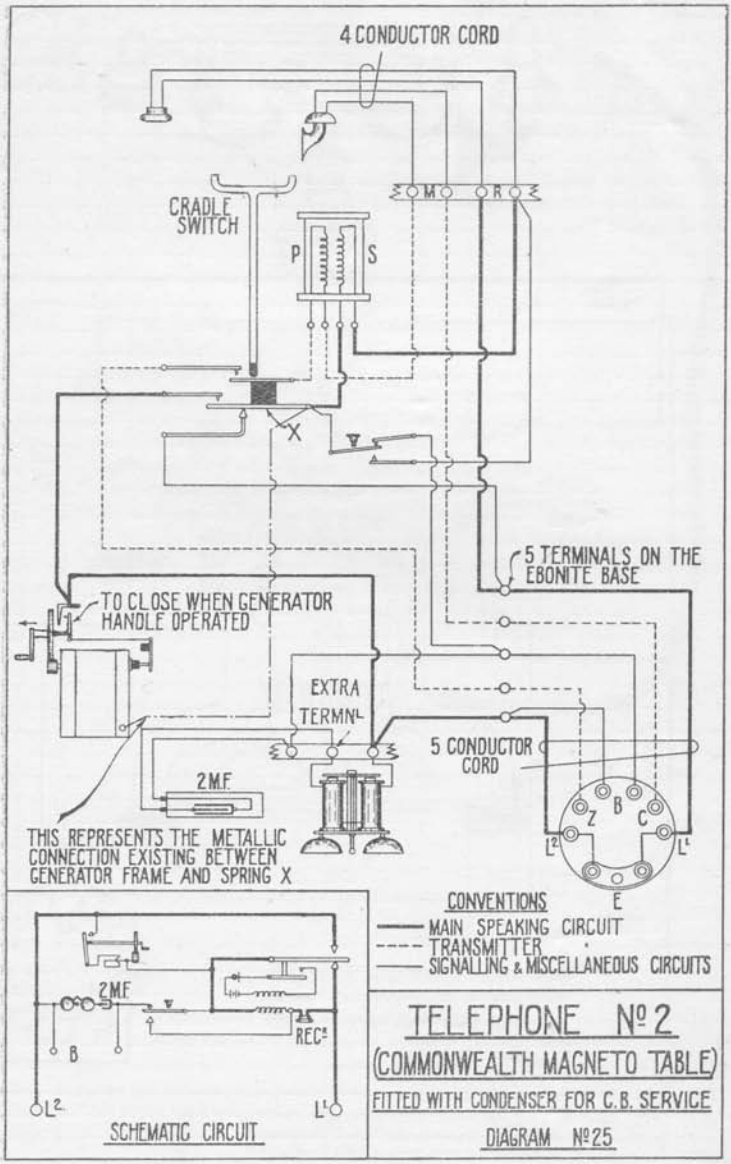
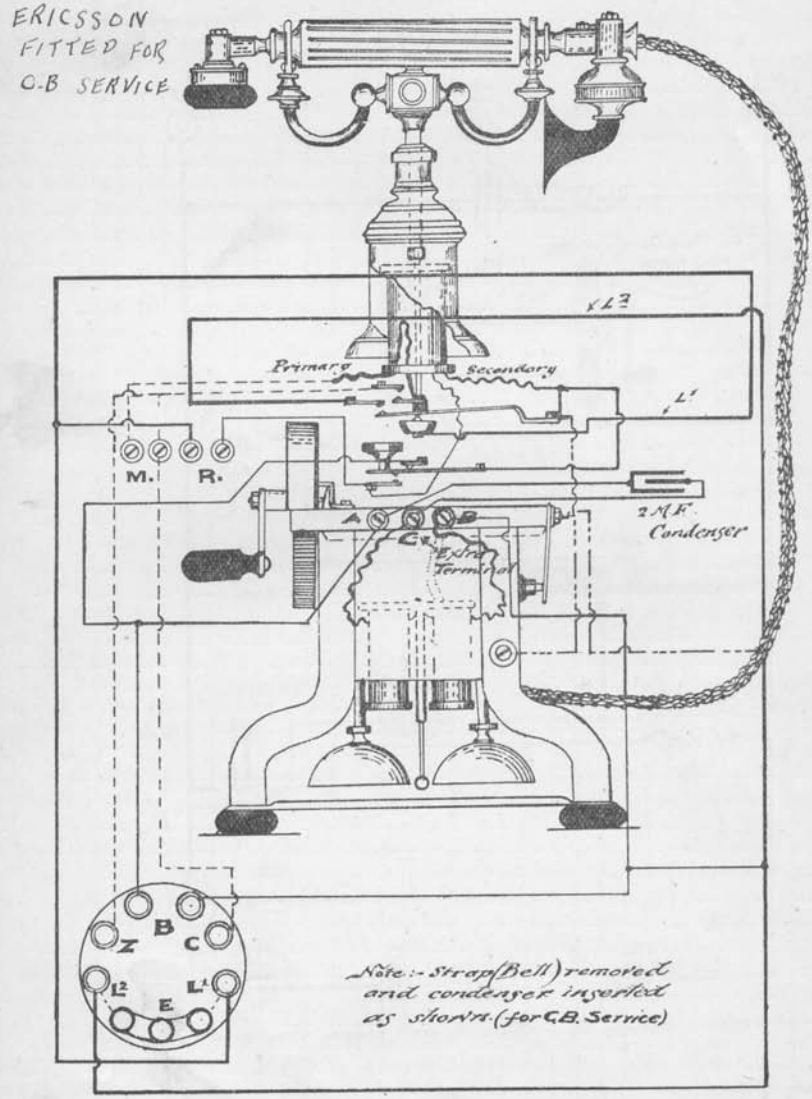


Diagram 24.



Amendment No. 1. Issued 13/12/16.

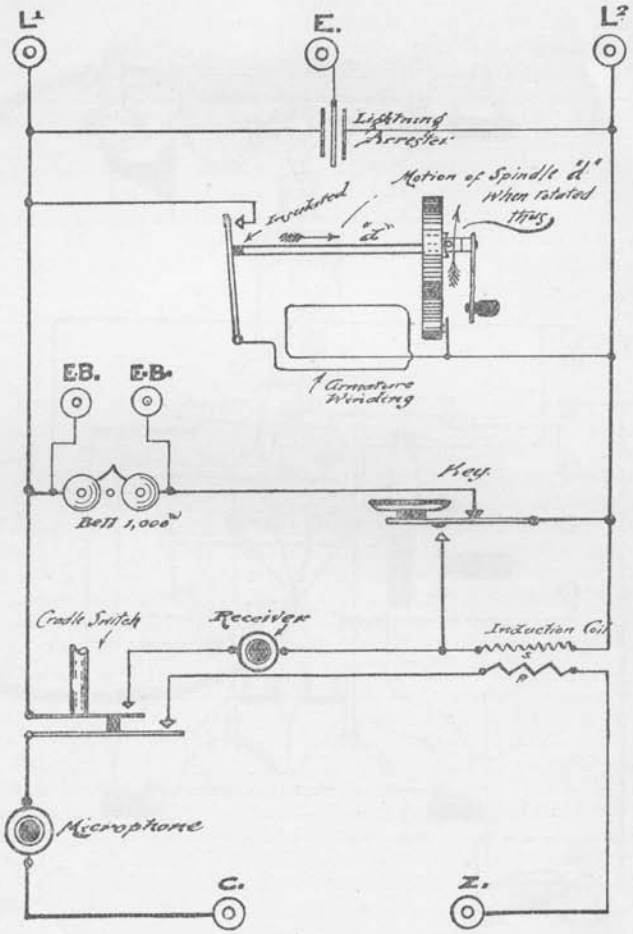
Diagram 25.



Note:- For Magneto Service, the extra terminal C and Condenser are not required. The Bell Coils are connected to Terminals A & B.

Diagram 25.

COMMONWEALTH MAGNETO
TABLE SCHEMATIC



When Generator is idle circuit from L¹ to L² through Armature Windings is open.

Diagram 26.

ERICSSON TABLE

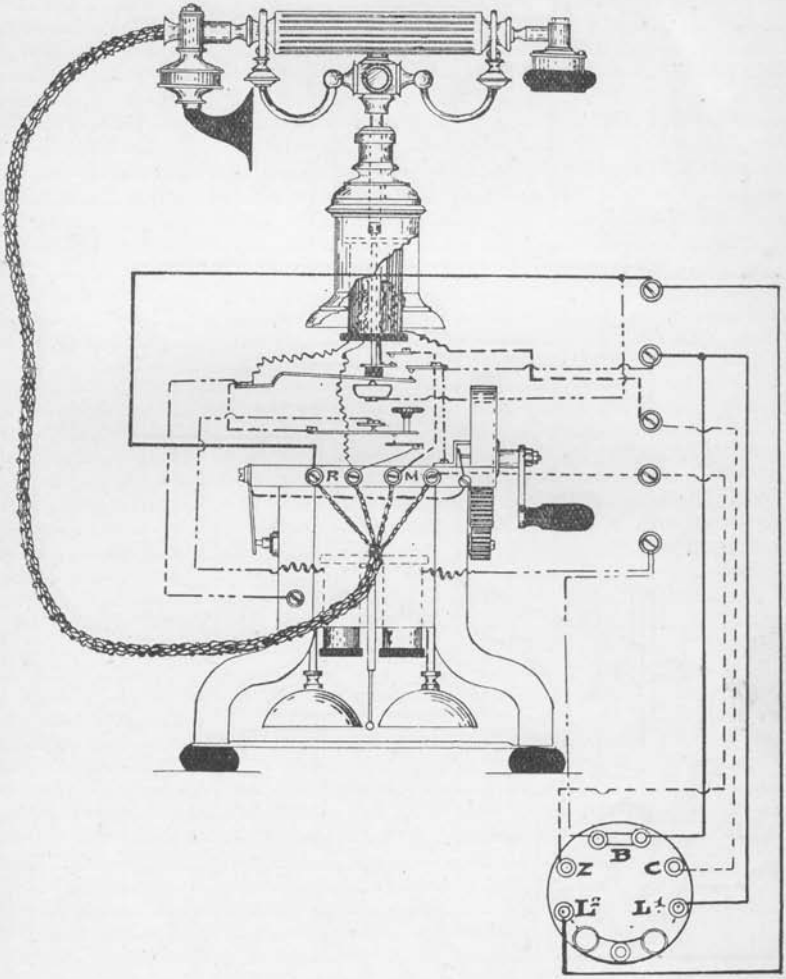


Diagram 27.

ERICSSON
FITTED WITH CONDENSER FOR CB
SERVICE WITHOUT EXTENSION BELL

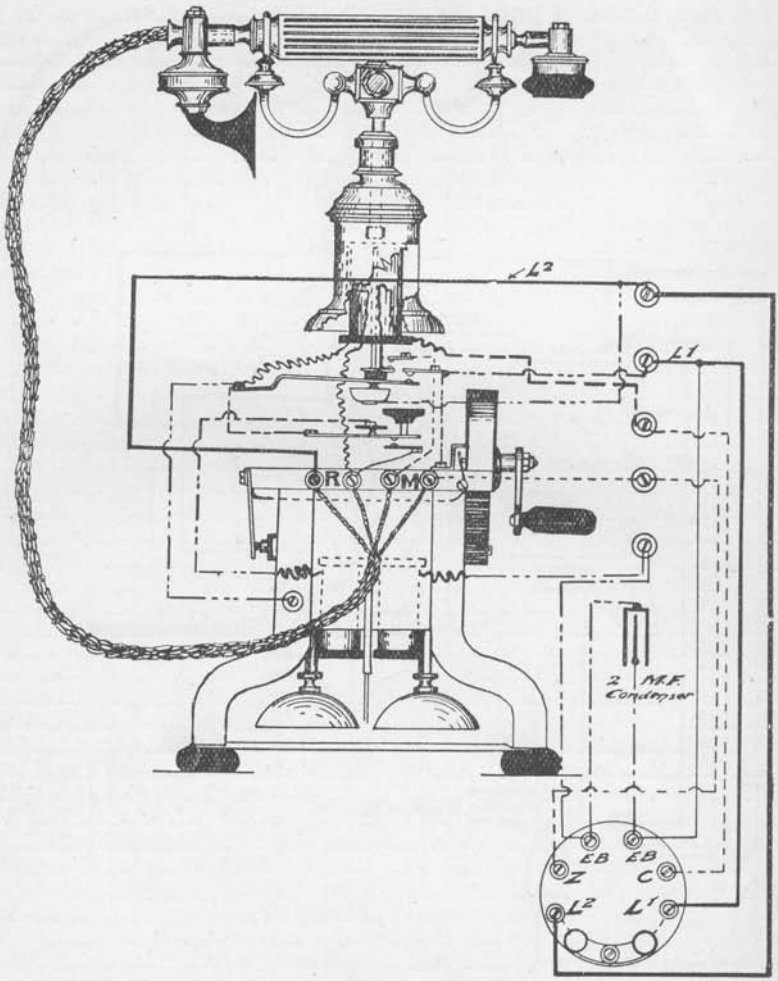


Diagram 28.

ERICSSON
FITTED WITH CONDENSER FOR C.B
SERVICE WITH EXTENSION BELL

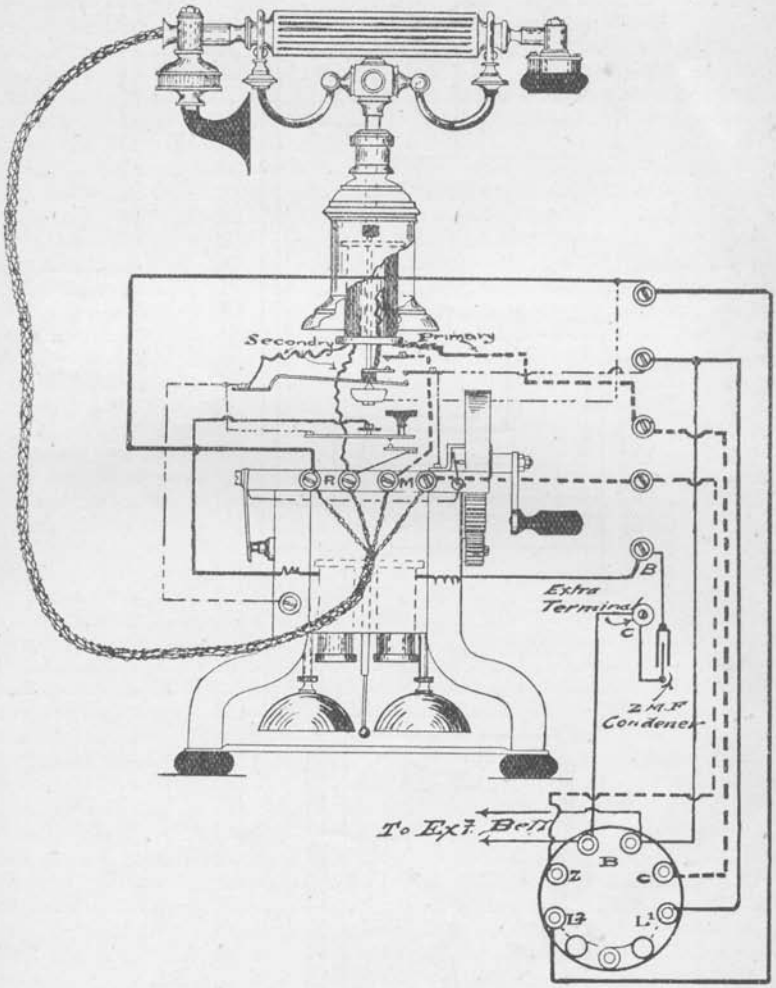
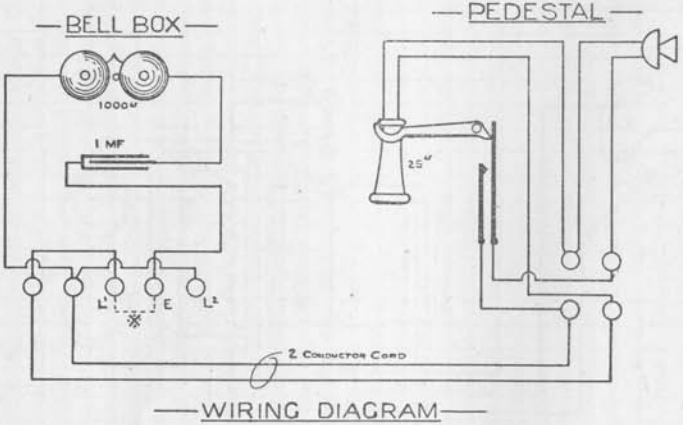
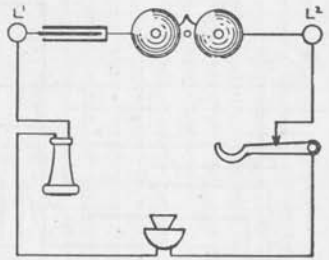


Diagram 29.

COMMON BATTERY SERIES WITH ELECTRO MAGNETIC RECEIVER G.E. TYPE



WIRING DIAGRAM



THEORY OF CONNECTIONS

※ NB When Extension Bell is installed remove Jumper and connect between L' & E.

Diagram 30.

ERICSSON C.B
TABLE

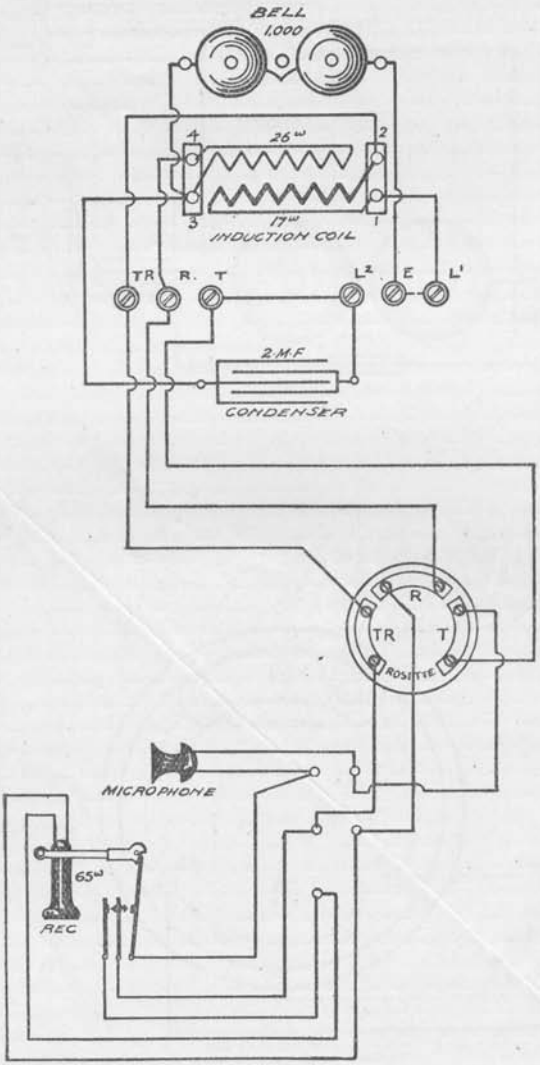


Diagram 31.

ERICSSON C.B
TABLE

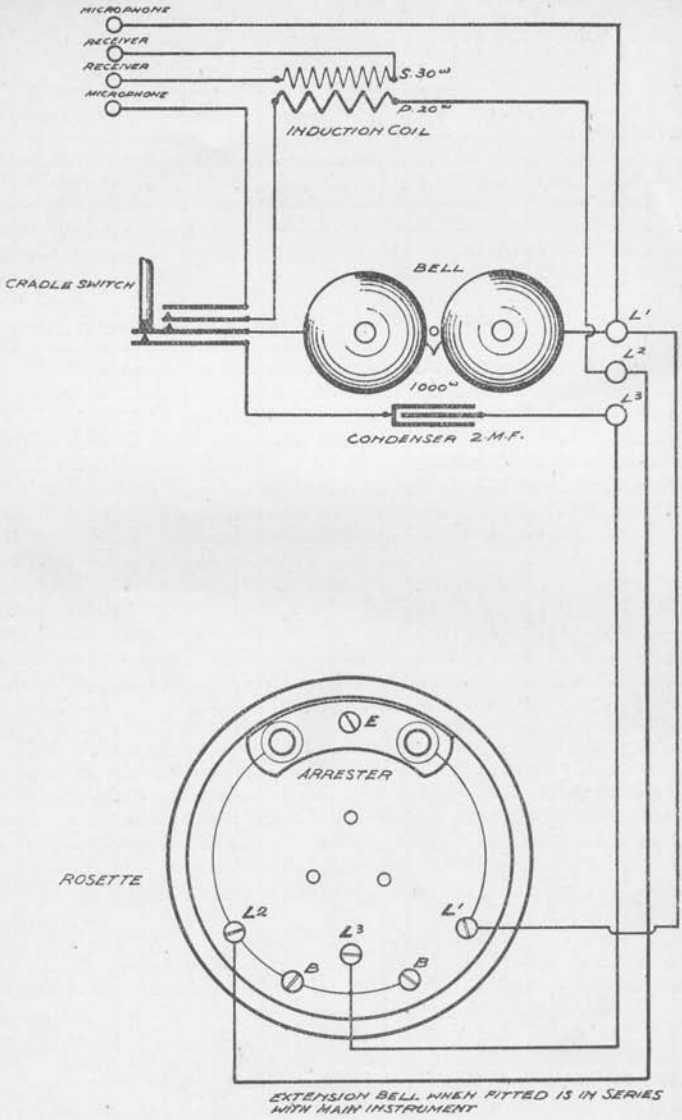


Diagram 32.

SECTION 3.

Telephones for Superimposed Circuits.

ERICSSON CONDENSER
TYPE

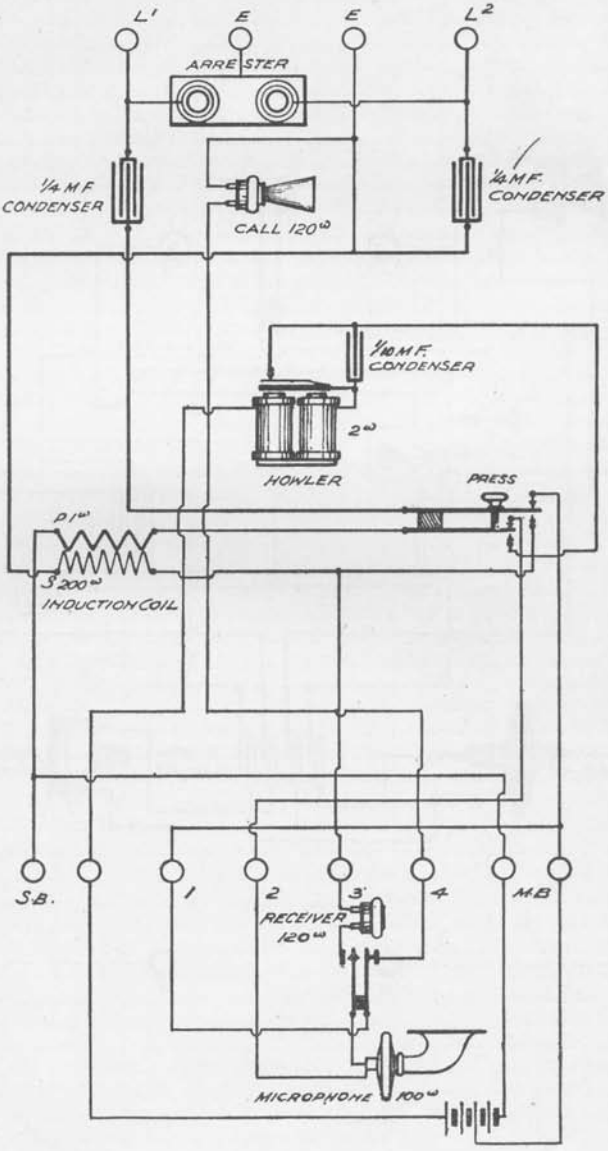


Diagram 33.

CONDENSER . BUZZER

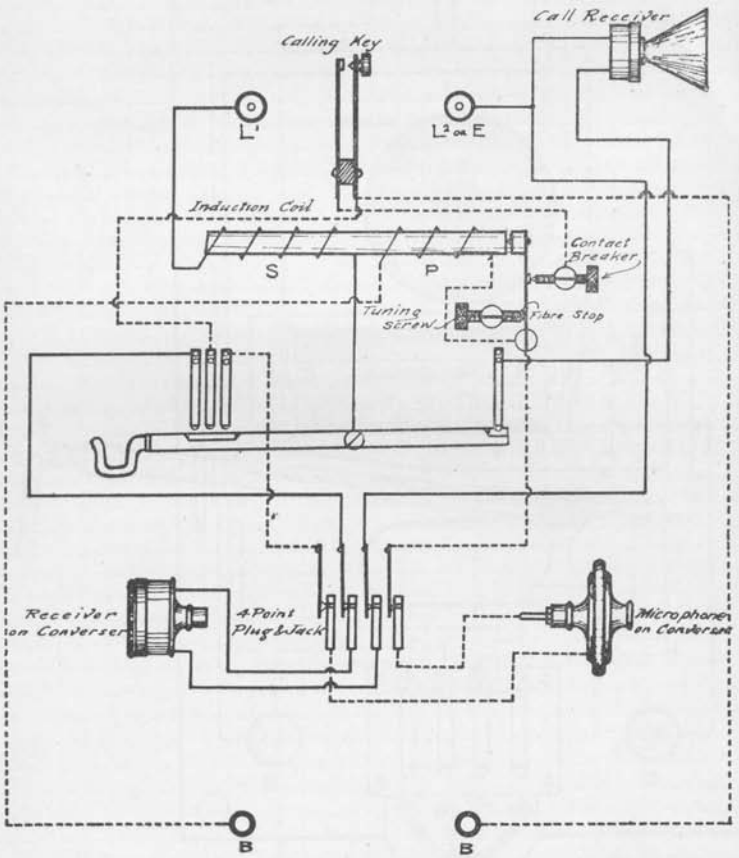


Diagram 34.

CLOSED CIRCUIT BUZZER.

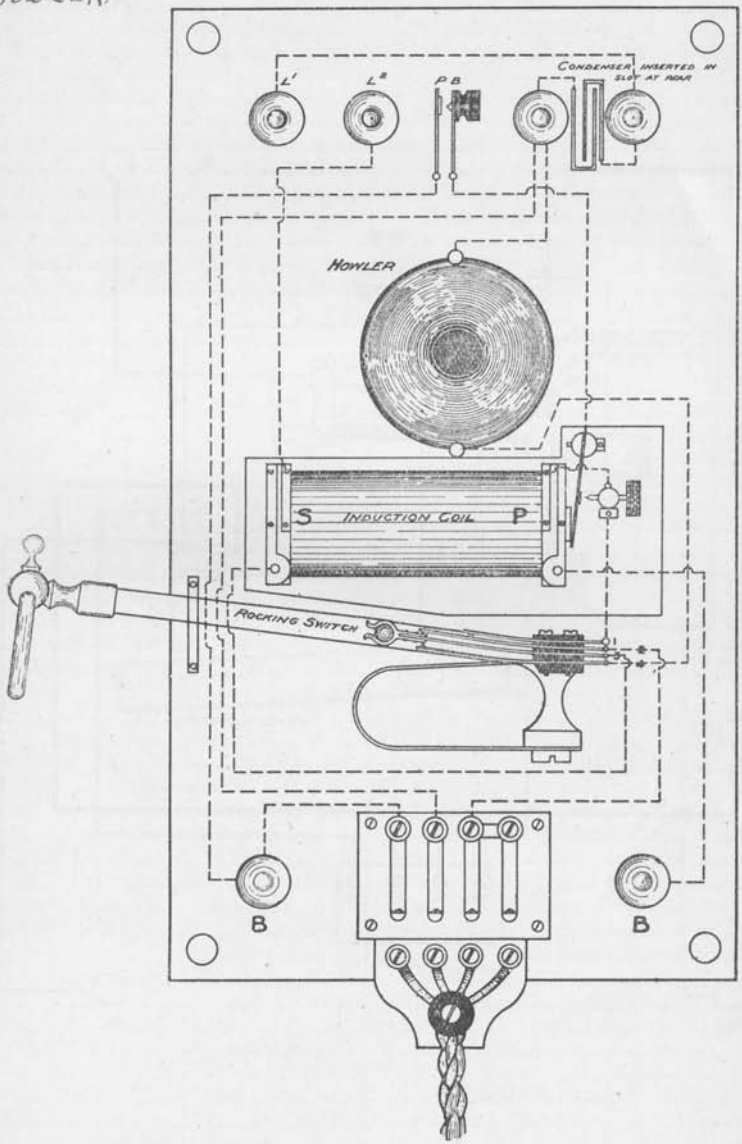


Diagram 35.

OPEN CIRCUIT
BUZZER.

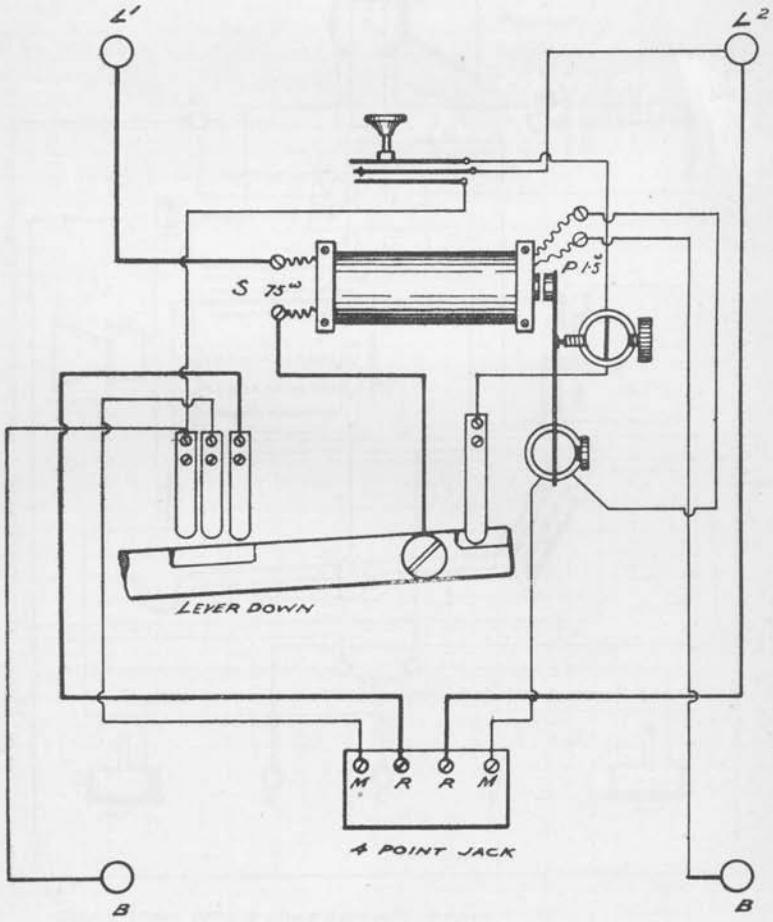
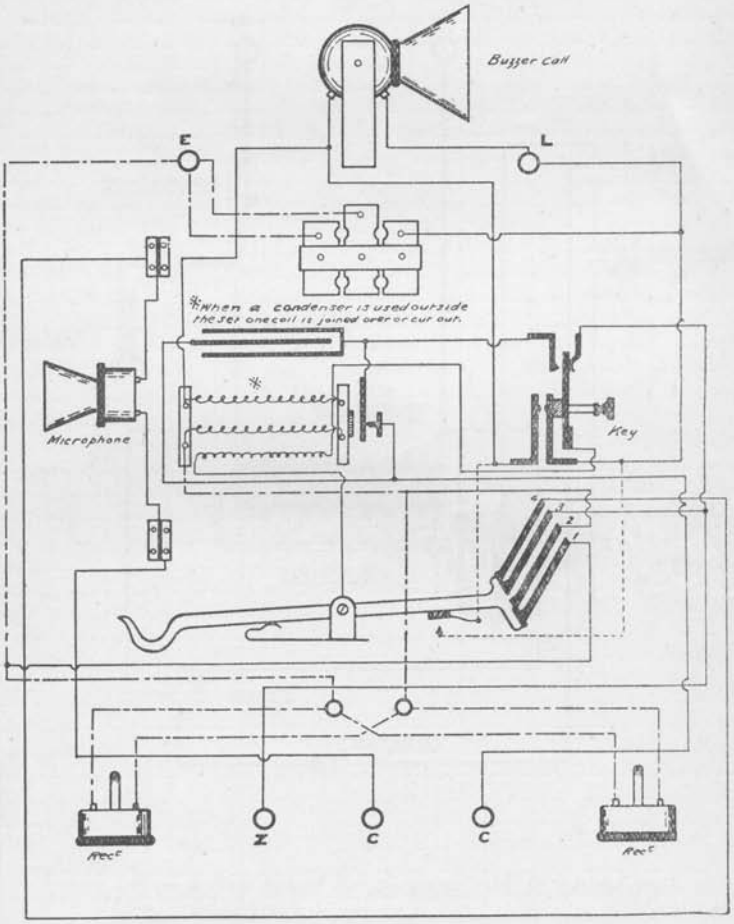


Diagram 36.

PHONOPORE



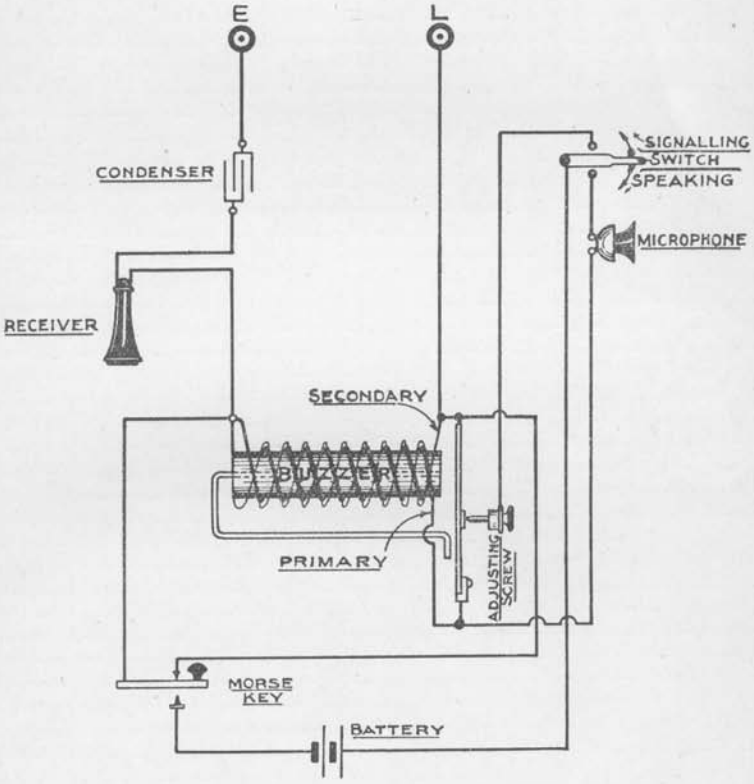
Switch down Nos 1, 2 and 3 contact, 4 open

Switch up No 4 contact, 1, 2 and 3 open

Diagram 37.

PORTABLE

MED HORST CIRCUIT



NOTE:- Morse Key must be pressed while speaking - or signalling

Diagram 38.

Part II.—Switches and Switchboards

SECTION 1.

Switches—Magneto and Common Battery.

ERICSSON MAGNETO
INTERMEDIATE SWITCH

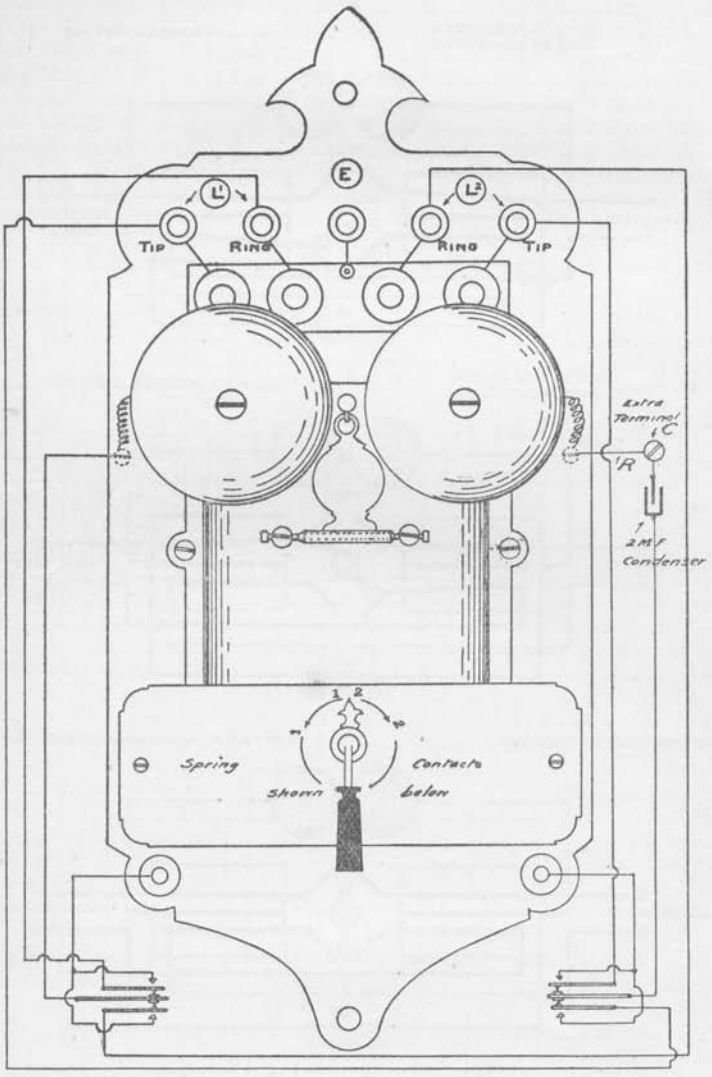


Diagram 39.

ERICSSON THREE POSITIONS

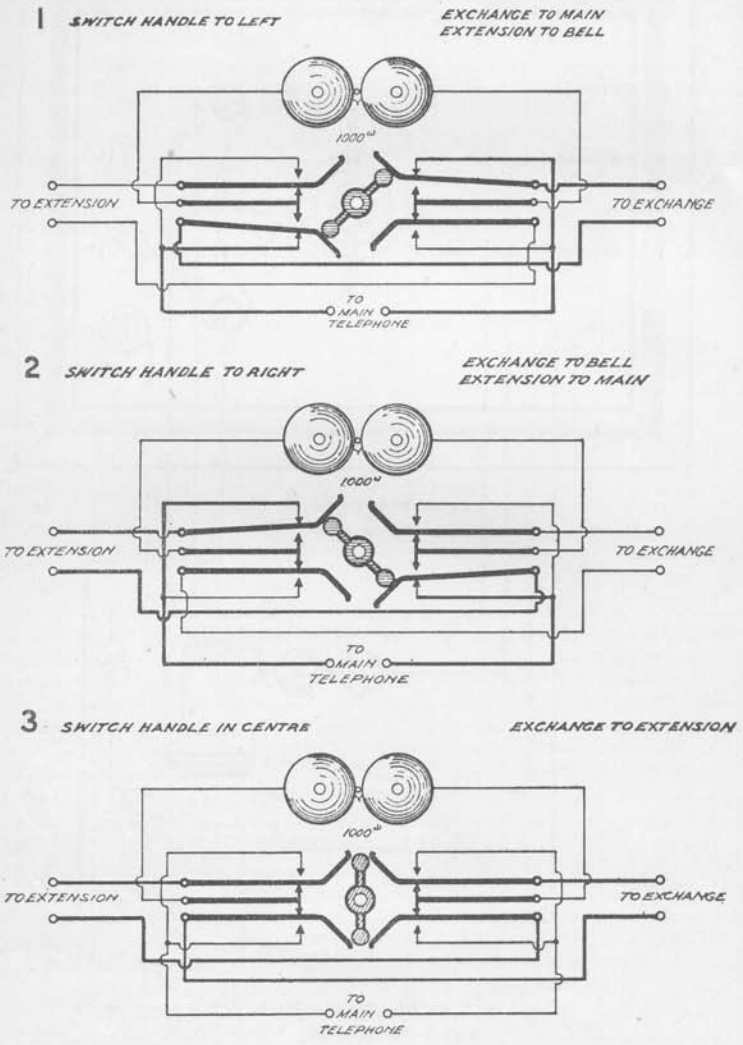
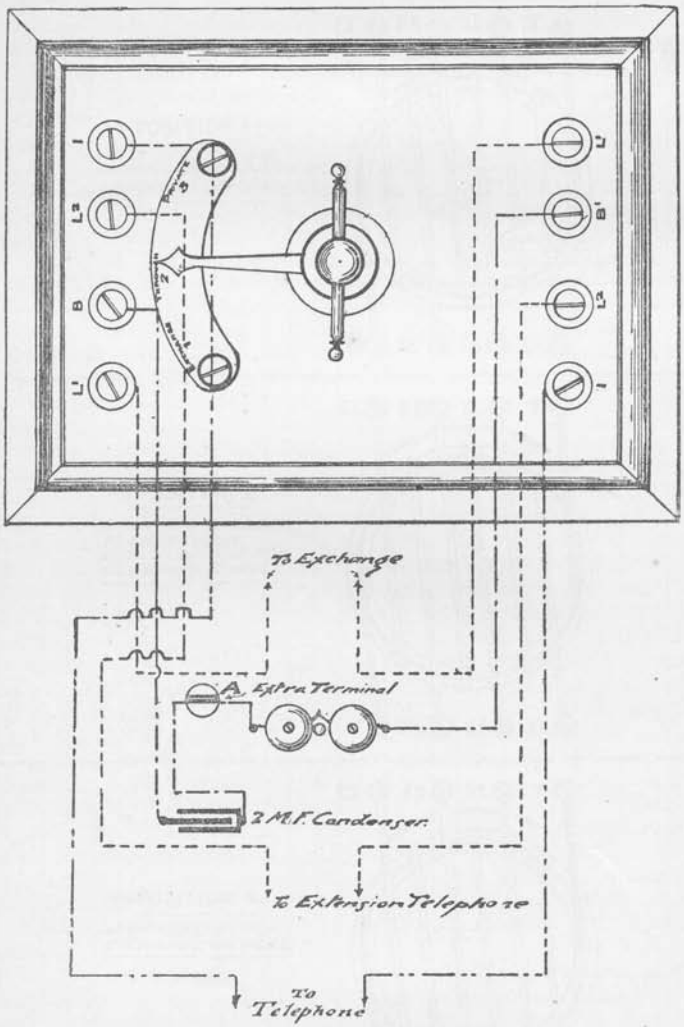


Diagram 40.

MAGNETO INTERMEDIATE CAPSTAN TYPE
FITTED WITH CONDENSER FOR CB SERVICE



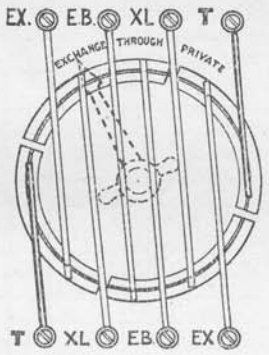
1st Position - L^2 to Instrument, L^2 to Bell.
2nd " - L^1 to L^2, Bell in Bridge.
3rd " - L^2 to Instrument, L^1 to Bell.

Diagram 41.

DIAGRAM SHOWING THREE POSITIONS

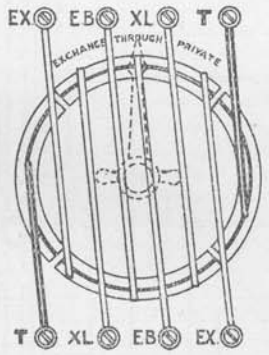
— POSITION 1. —

MAIN TO EXCHANGE EXTENSION (OR PRIVATE LINE) ON EXTENSION BELL



— POSITION 2. —

EXCHANGE THROUGH TO EXTENSION BELL IN BRIDGE FOR CLEARING SIGNAL



— POSITION 3. —

MAIN TO EXTENSION EXCHANGE ON BELL

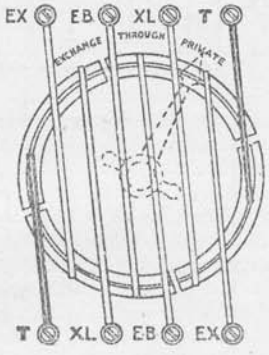


Diagram 42.

COMMON BATTERY SINGLE EXTENSION & INTER COMMUNICATION WITH VISUAL SIGNAL COMMON WEALTH TYPE.

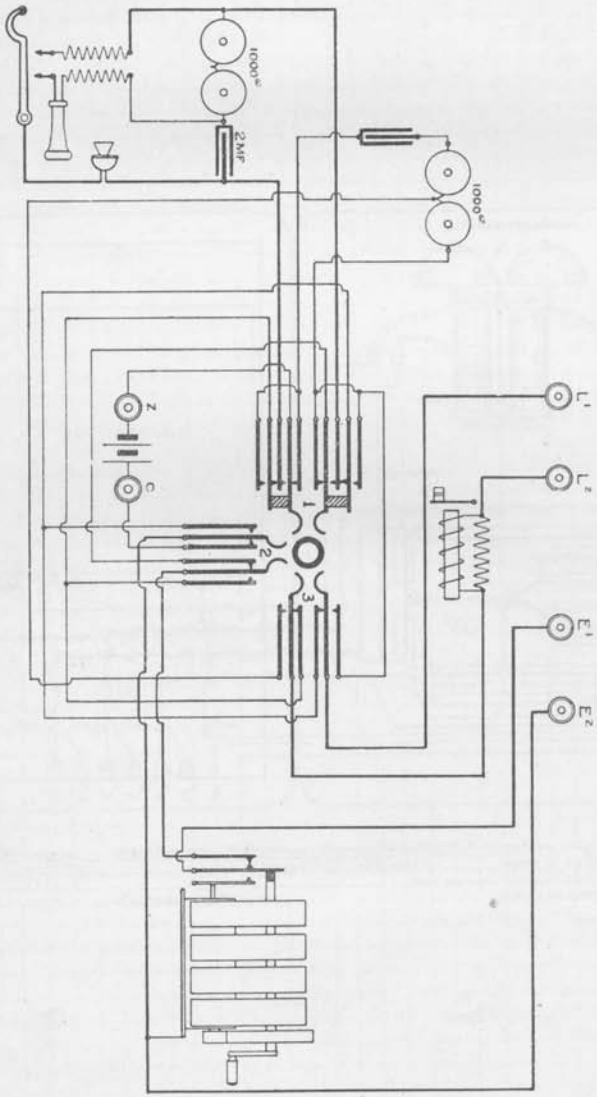
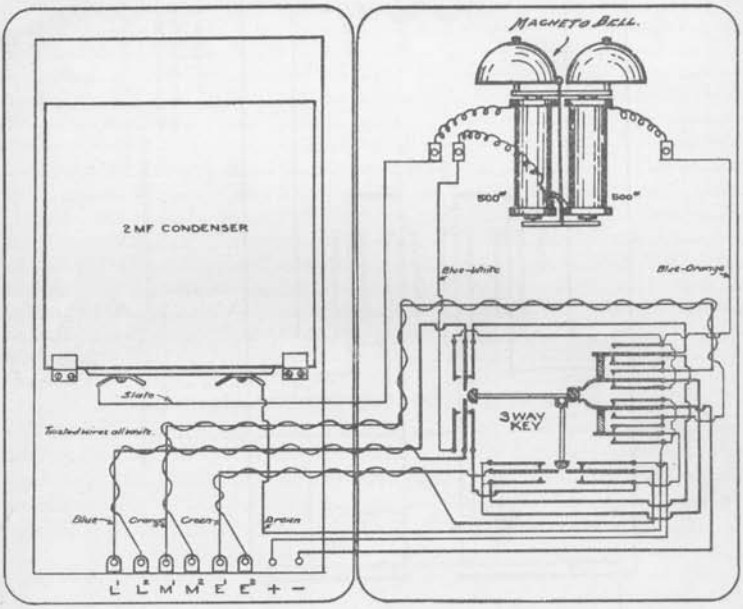


Diagram 43

COMMON BATTERY

INTERMEDIATE B.I. TYPE.



KEY NORMAL	Main Telephone to Exchange & Extension Tel on Ext^n Bell	NORMAL MAIN TO EXCH,
" IN N^o 1 POS^n	" " " Extension Tel. & Exchange " "	MAIN TO EXTEN. "
" " 1 & 3 "	" " " " " " held engaged	MAIN TO EXTN. EXCH. HELD
" " 2 "	Exchange to Extension	EXCH. TO EXTEN.

Diagram 44.

COMMON BATTERY
B·1

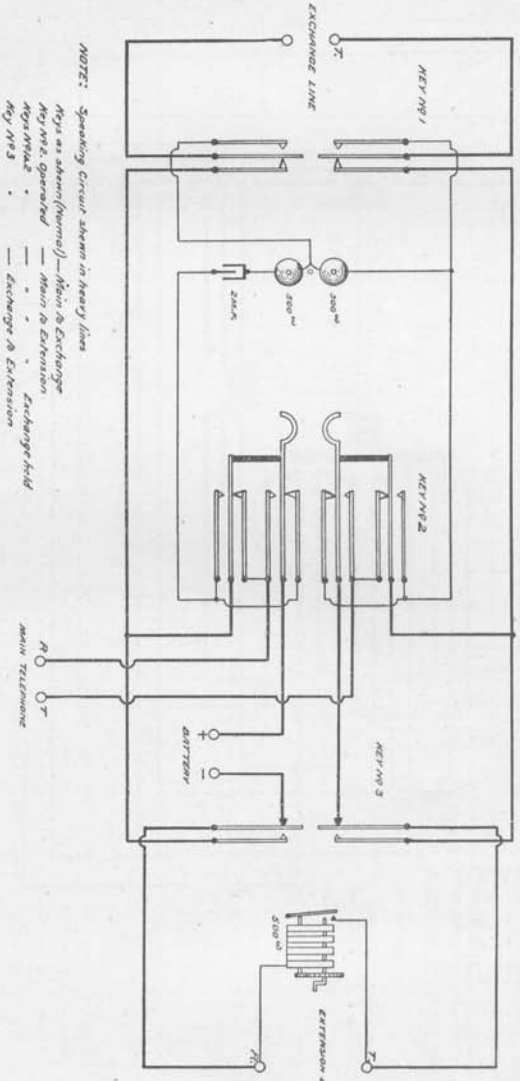


Diagram 45.

COMMON BATTERY

B.1.

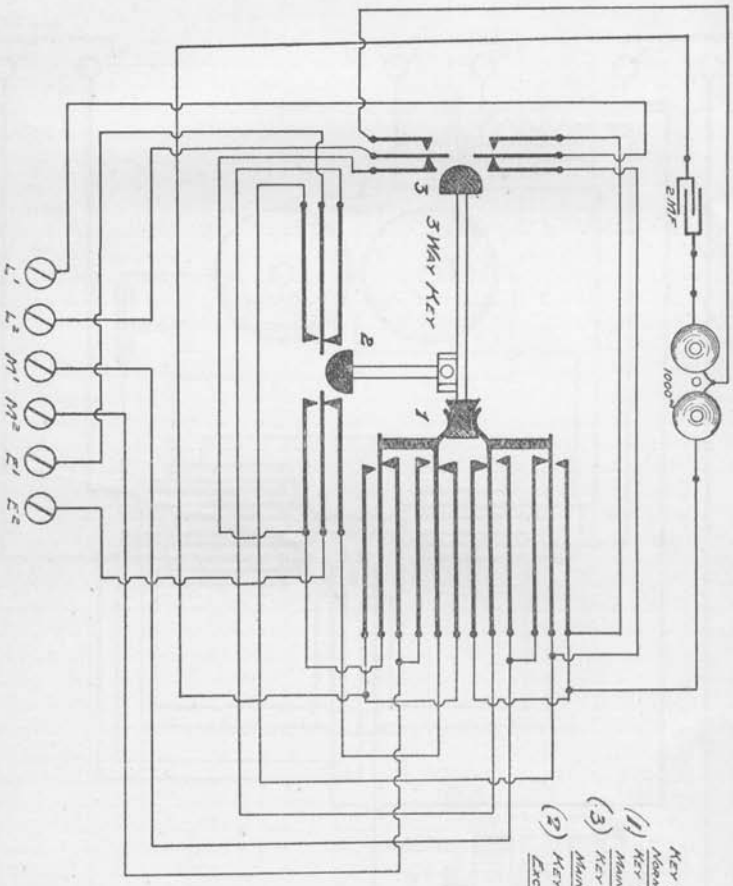


Diagram 46.

COMMON BATTERY SINGLE EXTENSION & INTER COMMUNICATION WITH VISUAL SIGNAL ERICSSON TYPE

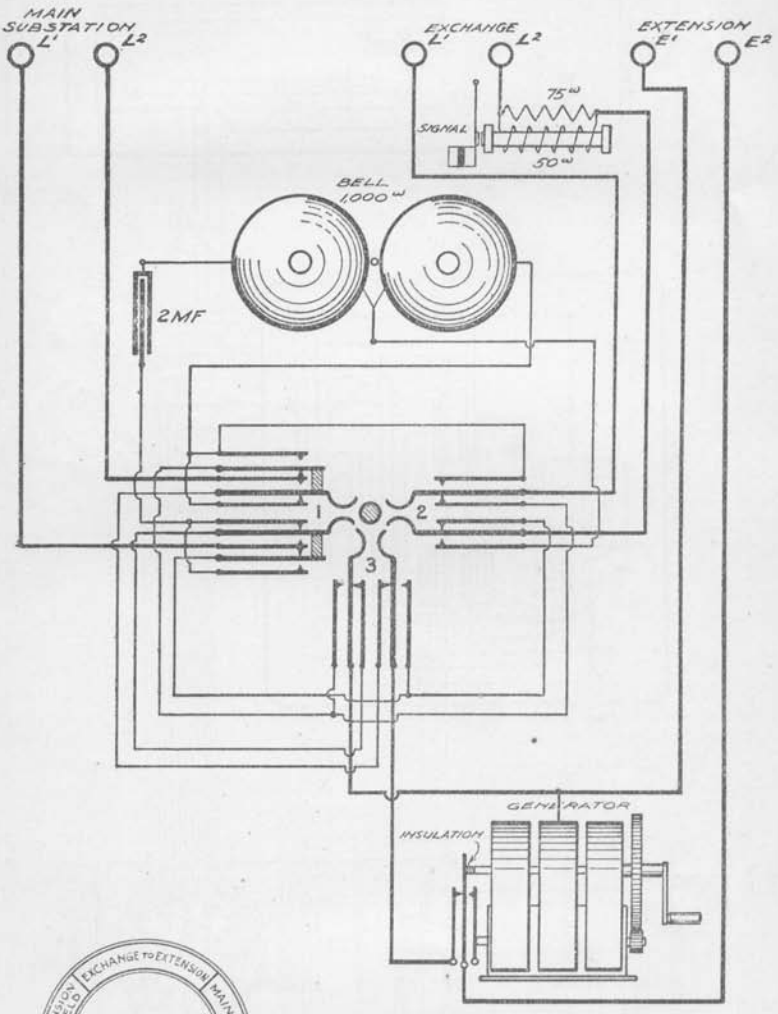


Diagram 47.

COMMON BATTERY
INTERMEDIATE WITH
PRESS BUTTONS. W.E TYPE

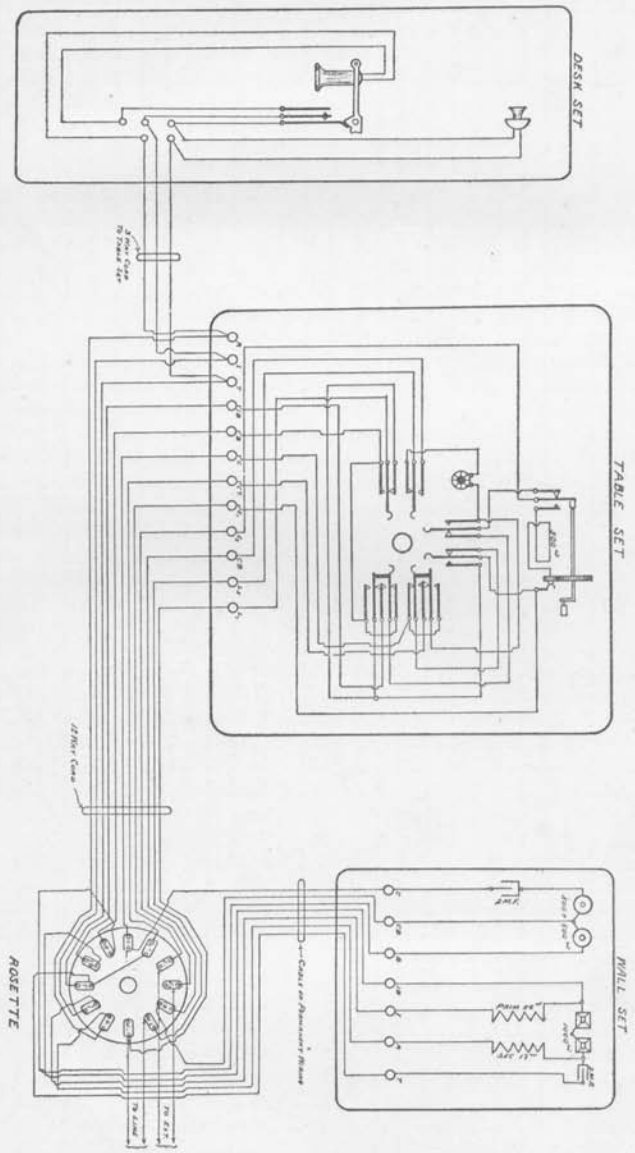


Diagram 48.

SECTION 2.

Switchboards, Cordless—Magneto and Common Battery.

ERICSSON MAGNETO CORDLESS PBX
PYRIMID TYPE

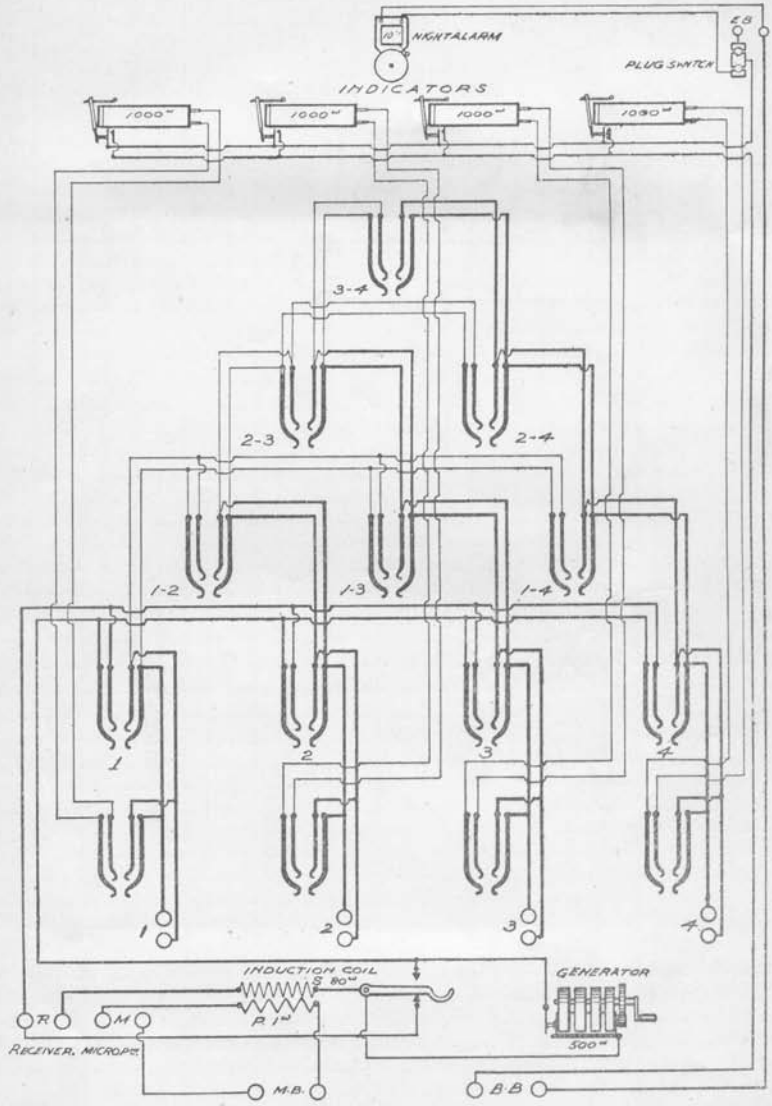
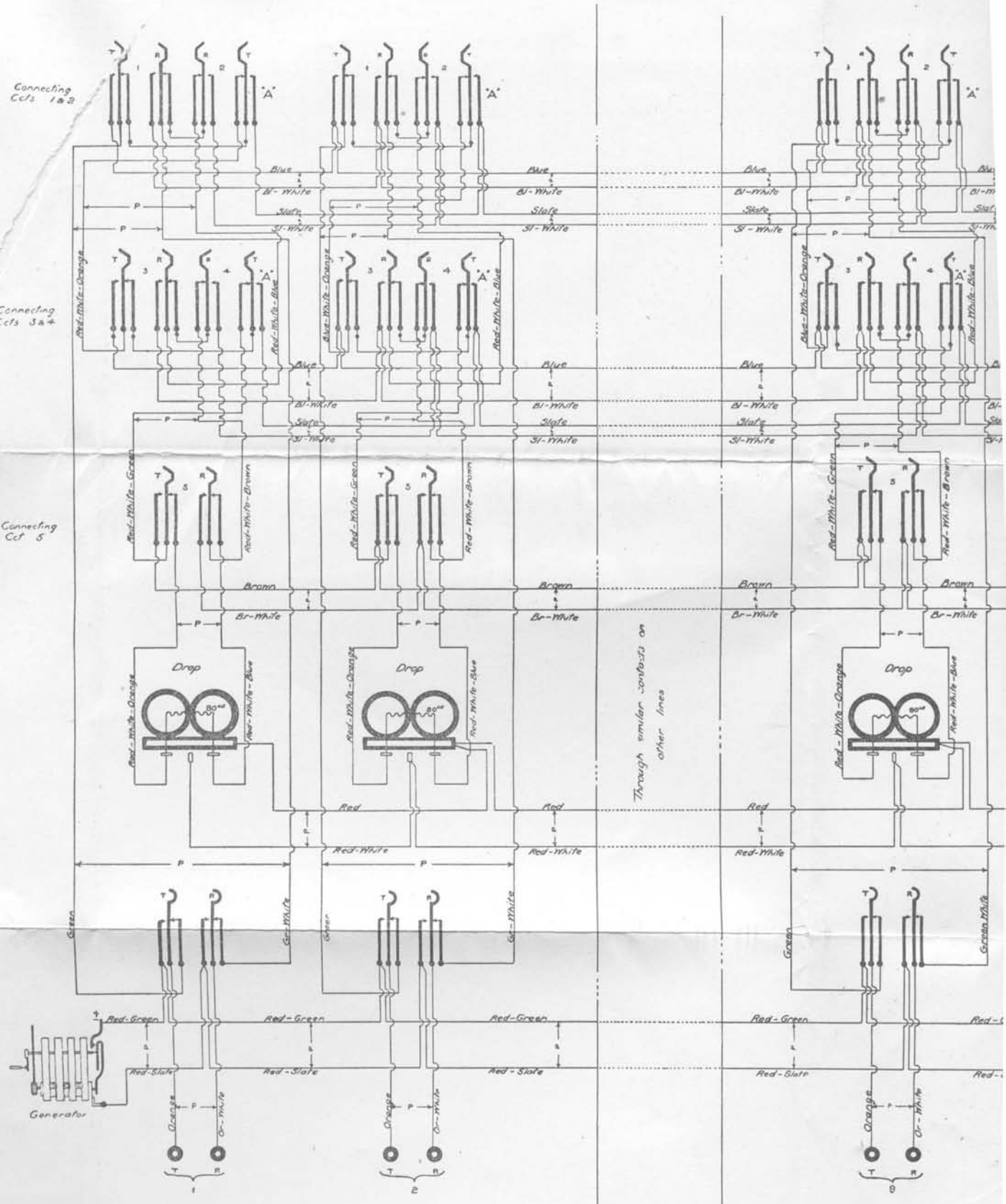


Diagram 49.

MAGNETO P.B.X

10 LINES

W.E. TYPE



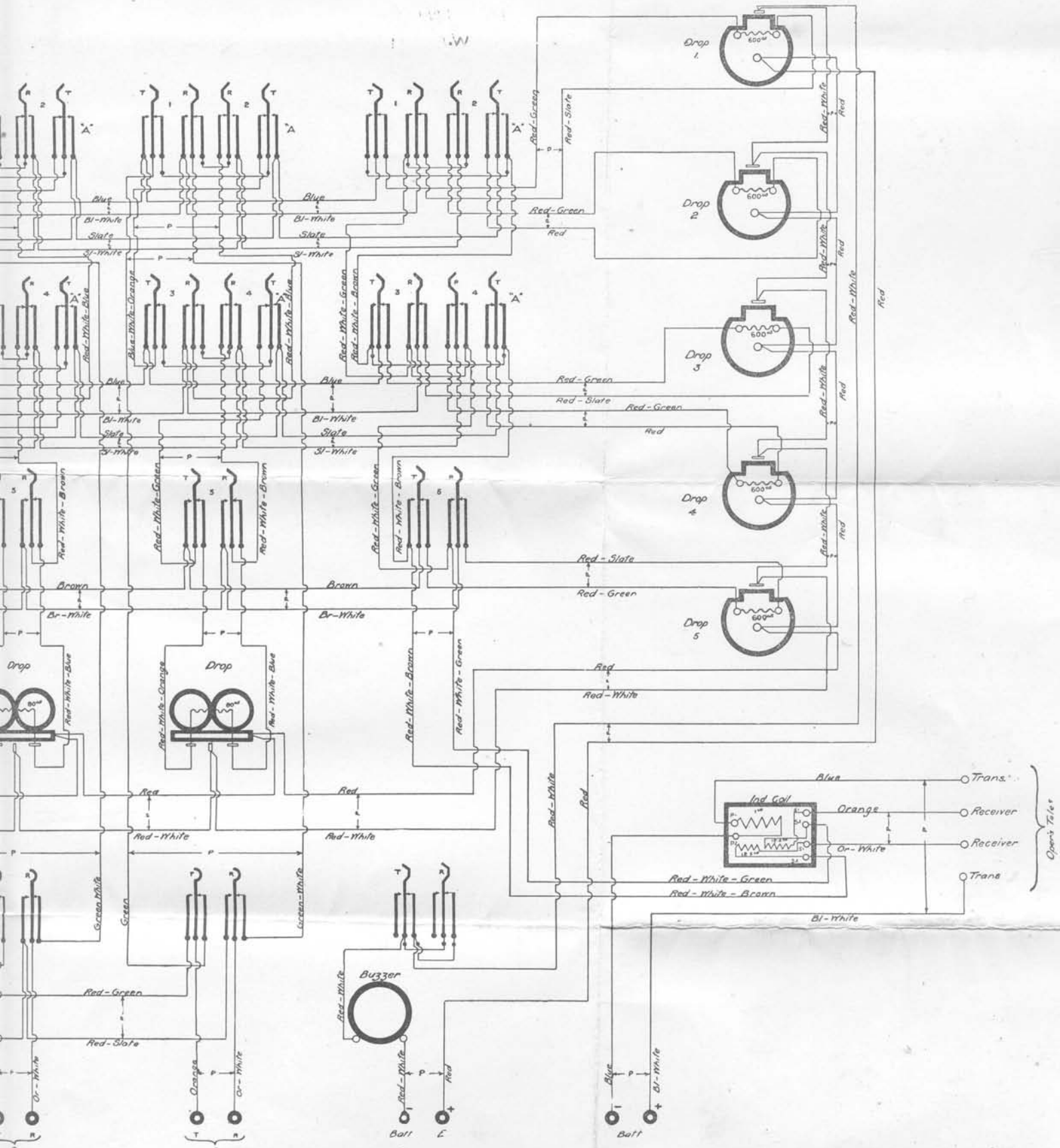
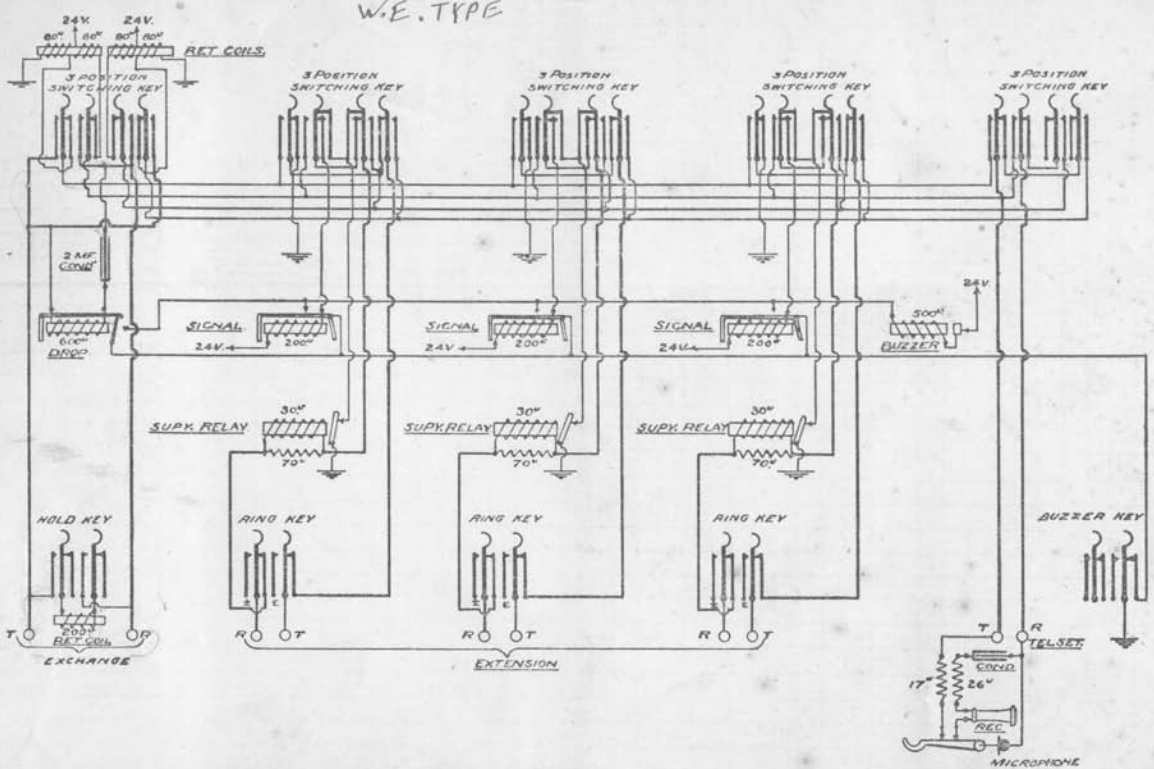

Drop 1
Drop 2
Drop 3
Drop 4
Drop 5
600 ohms
Red-Green
Red-Slate
Red-White
Red
Blue
Bl-White
Slate
Sl-White
Red-White-Blue
Blue-White-Orange
Red-White-Green
Red-White-Brown
Brown
Br-White
Drop
80 ohms
Red-White-Orange
Red-White-Green
Red-White-Brown
Green
Green-White
Orange
Or-White
Buzzer
Batt
Ind Coil
Trans.
Receiver
Receiver
Trans
Open Tele

Diagram 50.

Diagram 51.

ERICSSON

C.B. PBX


C.B P.B.X 4 LINES
W.E. TYPE
24V.
24V.
60Ω
60Ω
60Ω
60Ω
RET COILS
3 POSITION SWITCHING KEY
3 POSITION SWITCHING KEY
3 POSITION SWITCHING KEY
3 POSITION SWITCHING KEY
3 POSITION SWITCHING KEY
2 MF. COND.
60Ω
DROP
SIGNAL
24V
200Ω
SIGNAL
24V
200Ω
SIGNAL
24V
200Ω
24V
500Ω
BUZZER
SUPV. RELAY
30Ω
70Ω
SUPV. RELAY
30Ω
70Ω
SUPV. RELAY
30Ω
70Ω
HOLD KEY
RING KEY
RING KEY
RING KEY
BUZZER KEY
T
R
200Ω
RET. COILS
EXCHANGE
R
T
R
T
R
T
EXTENSION
T
R
TEL. SET
COND.
17Ω
26Ω
REC.
MICROPHONE

C. B P.B.X
4 LINES B.1 TYPE

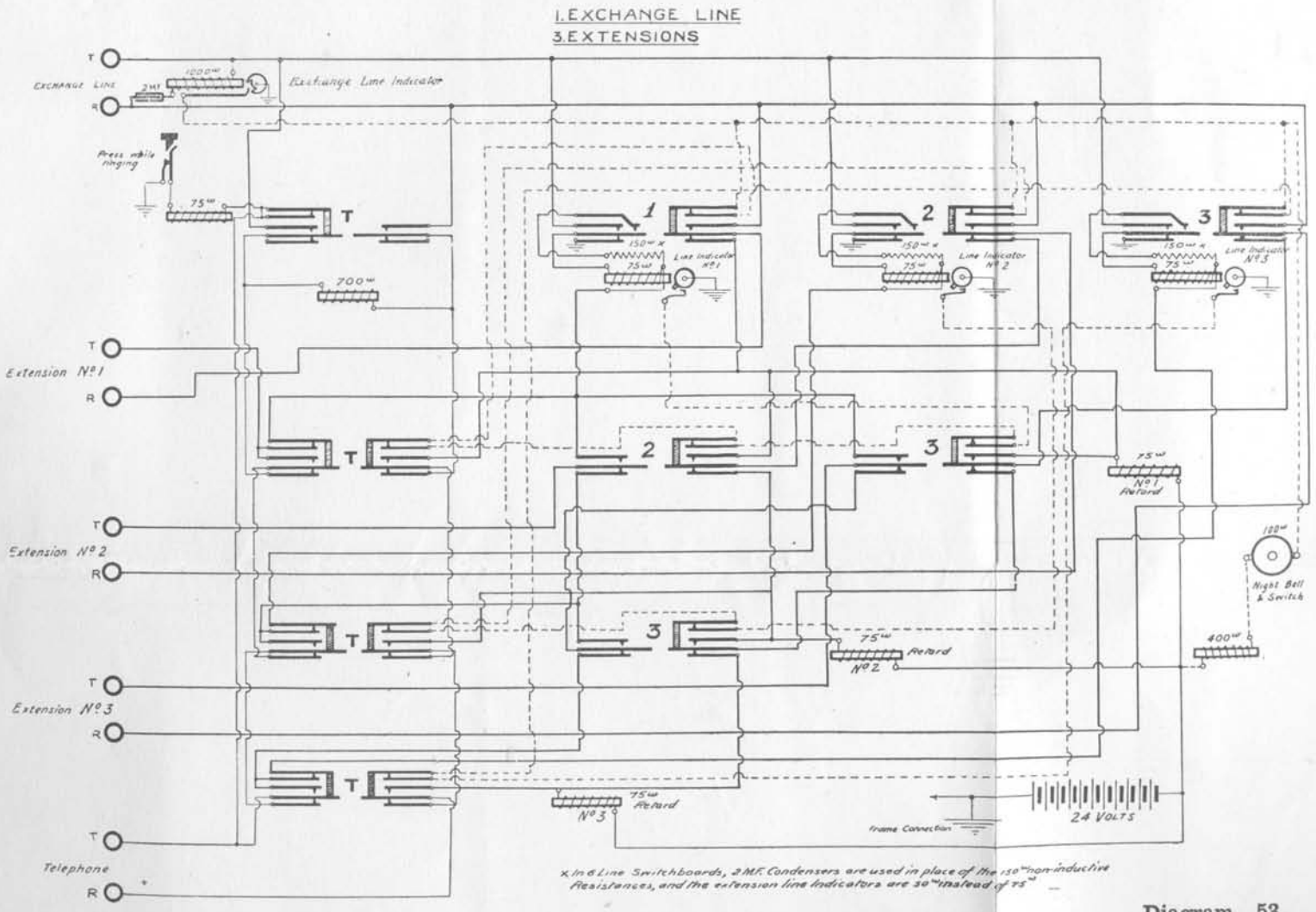


Diagram 53.

SECTION 3.

Switchboards, Cord—Magneto and Common Battery.

CORD P.B.X MAGNETO
B.1 TYPE

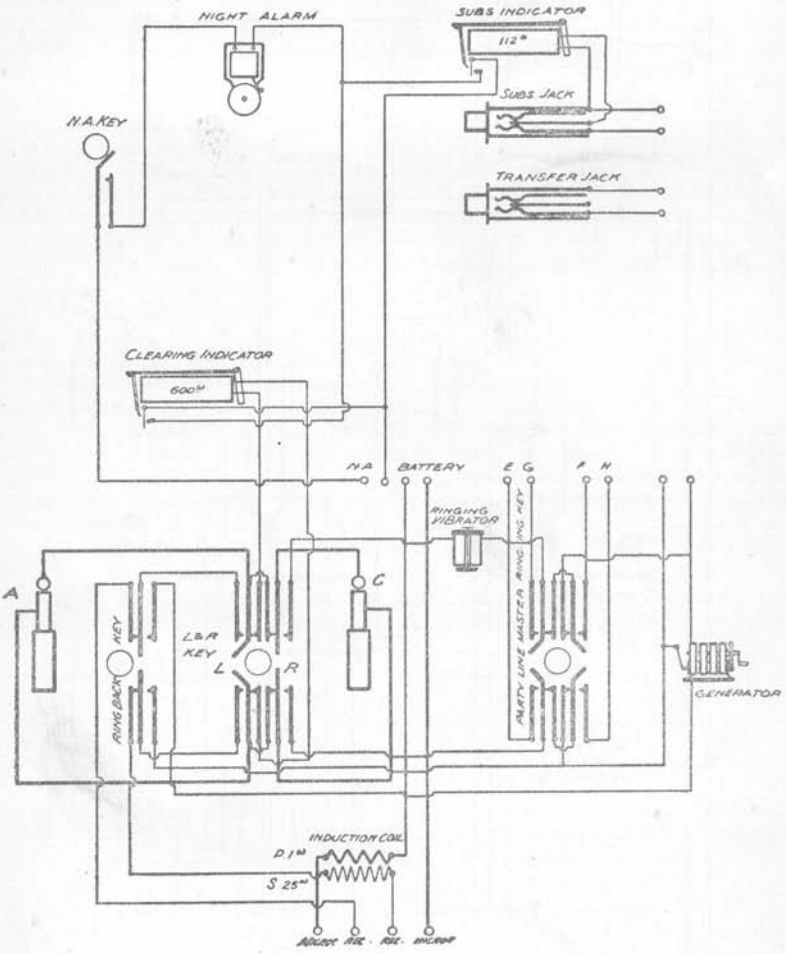


Diagram 54.

CORD P.B. XERICSSON, TYPE

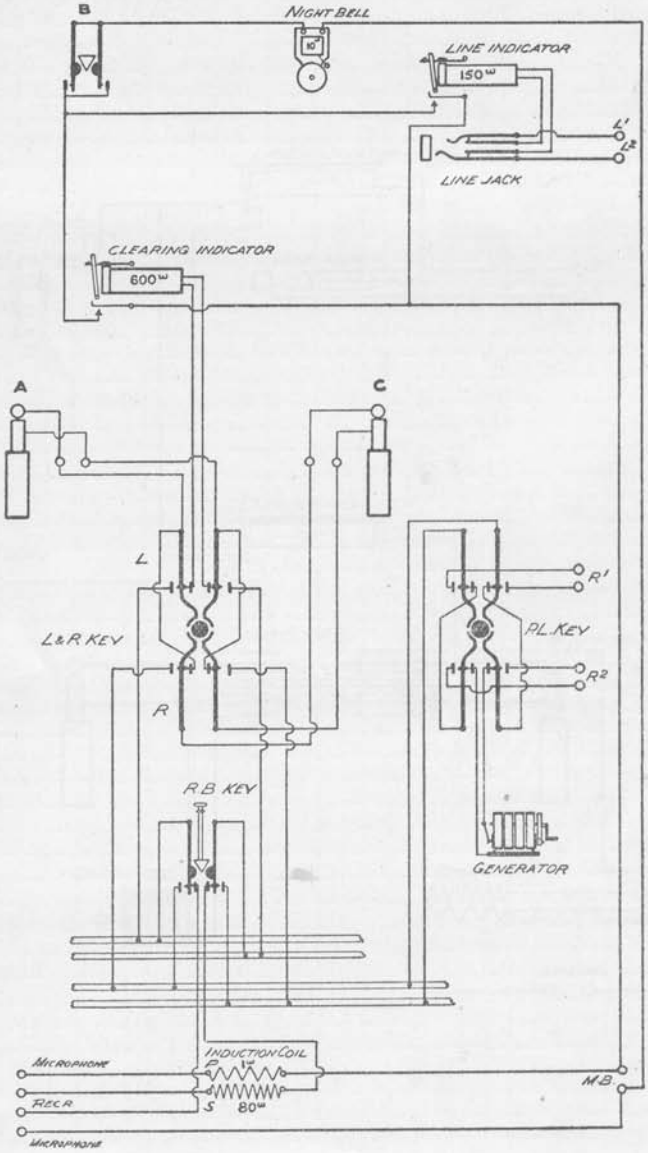


Diagram 55.

CORD PB-X
W.E TYPE

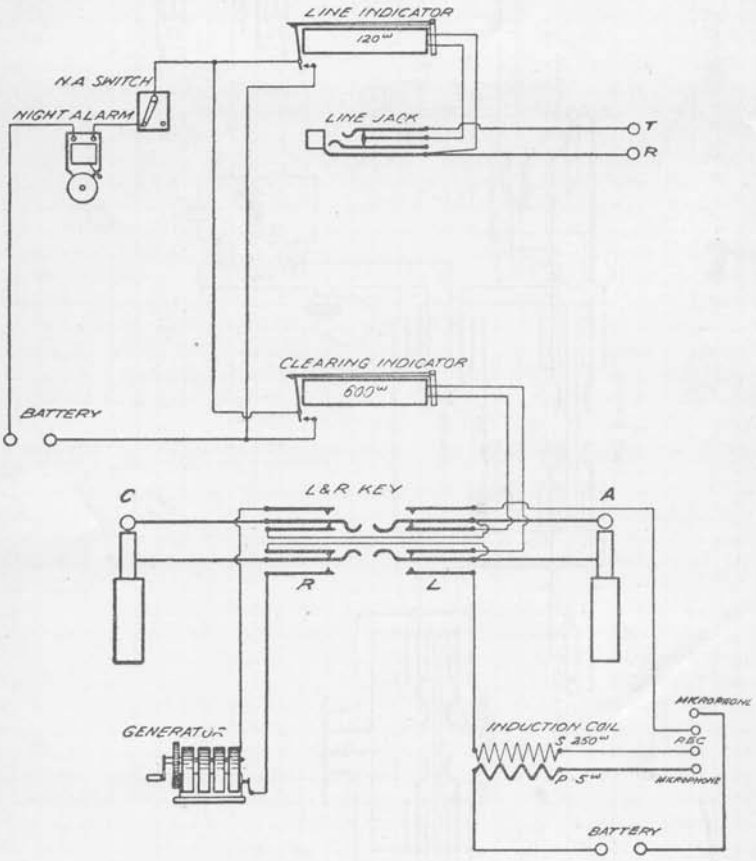


Diagram 56.

50 OR 100 LINE CORD PBX

W.E FLOOR PATTERN

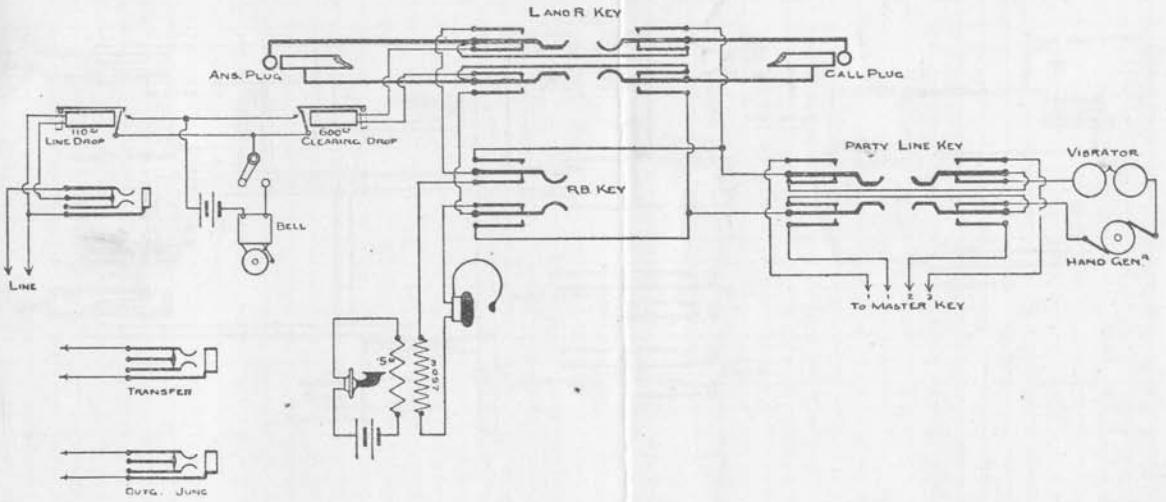


Diagram 57.

NON MULTIPLE
B - POSITION

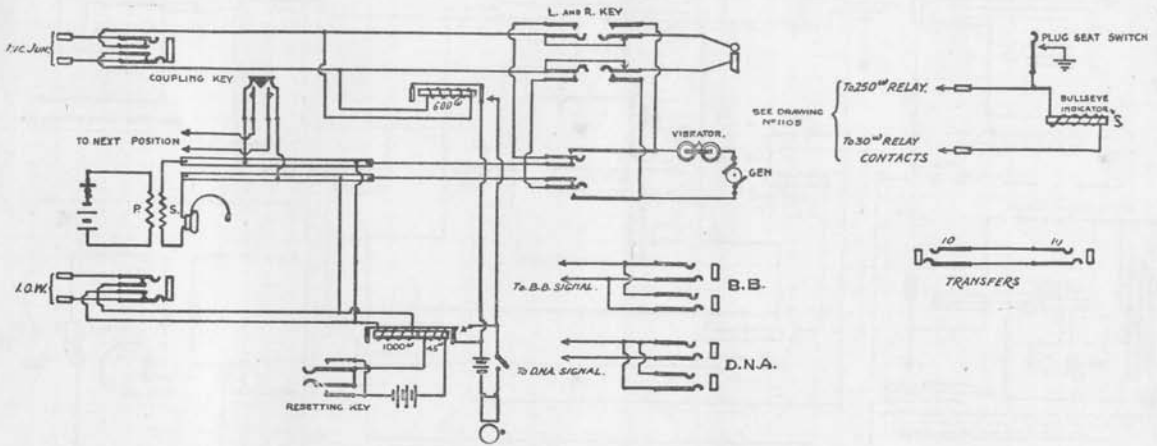


Diagram 58.

COMMON BATTERY CORD P.B.X
COMMONWEALTH TYPE

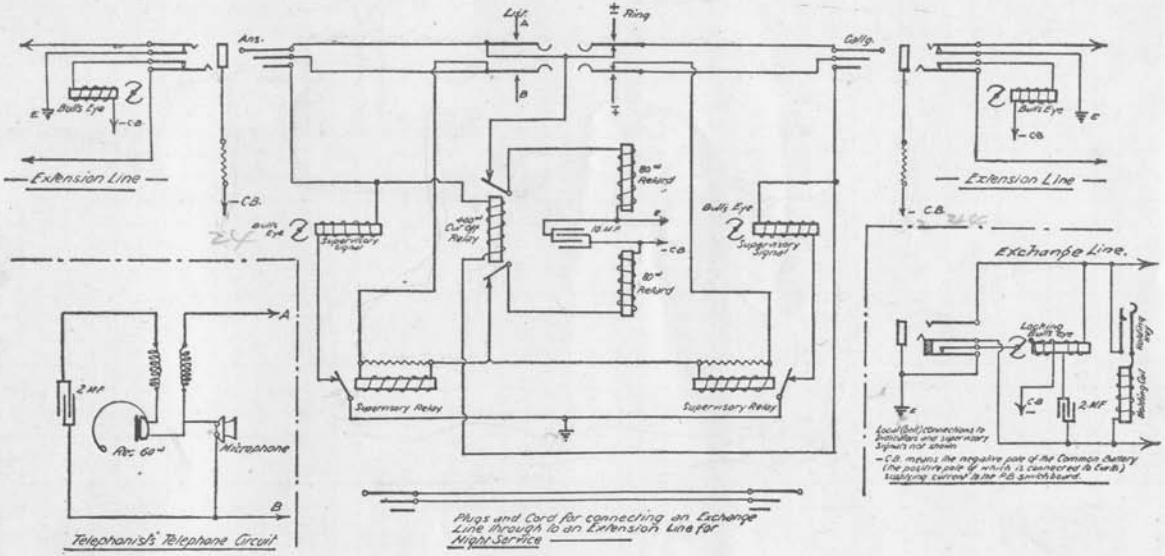
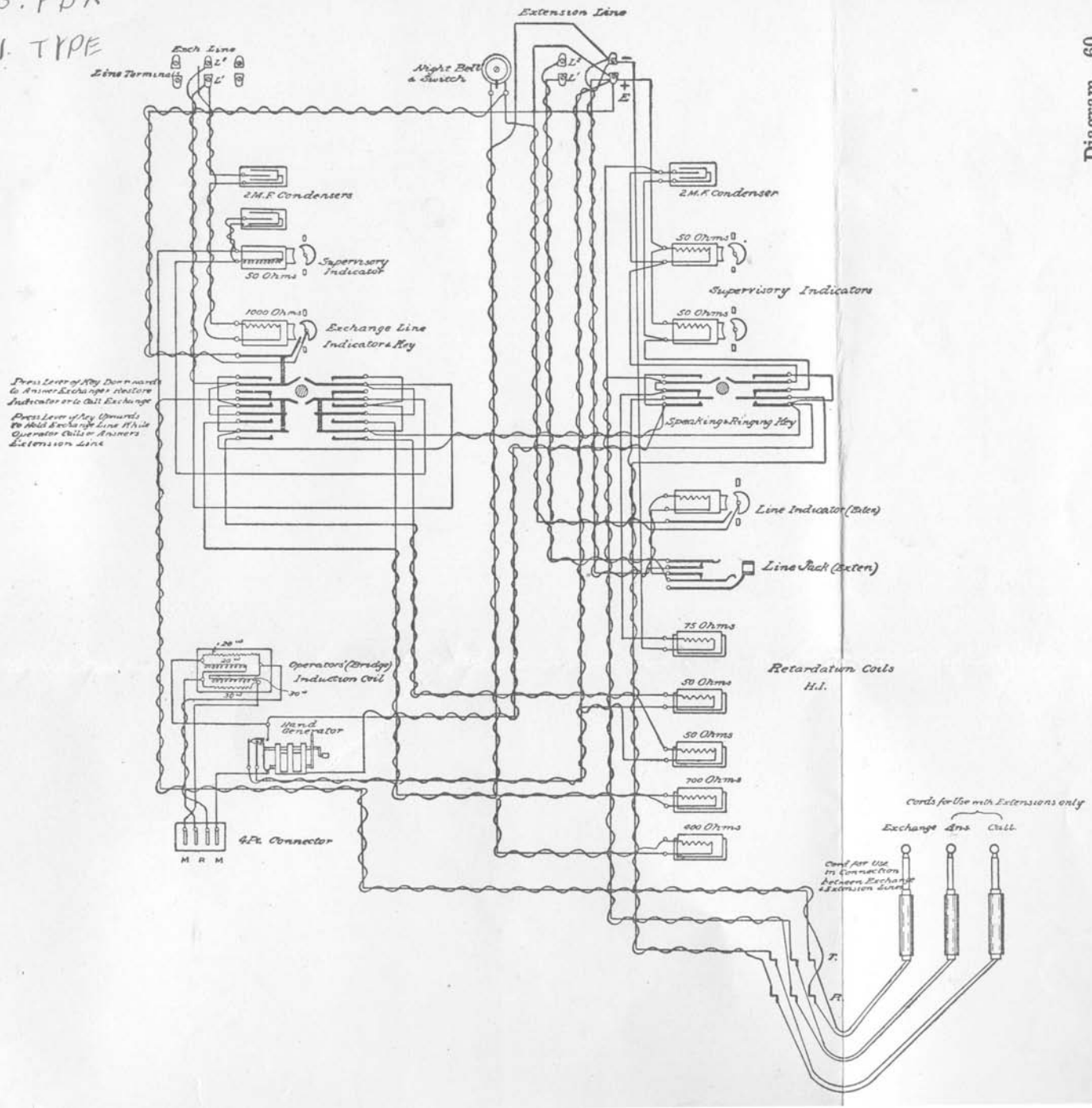


Diagram 59.

C.B. PBX

B.J. TYPE

Diagram 60.



C.B P.B.X. ERICSSON TYPE

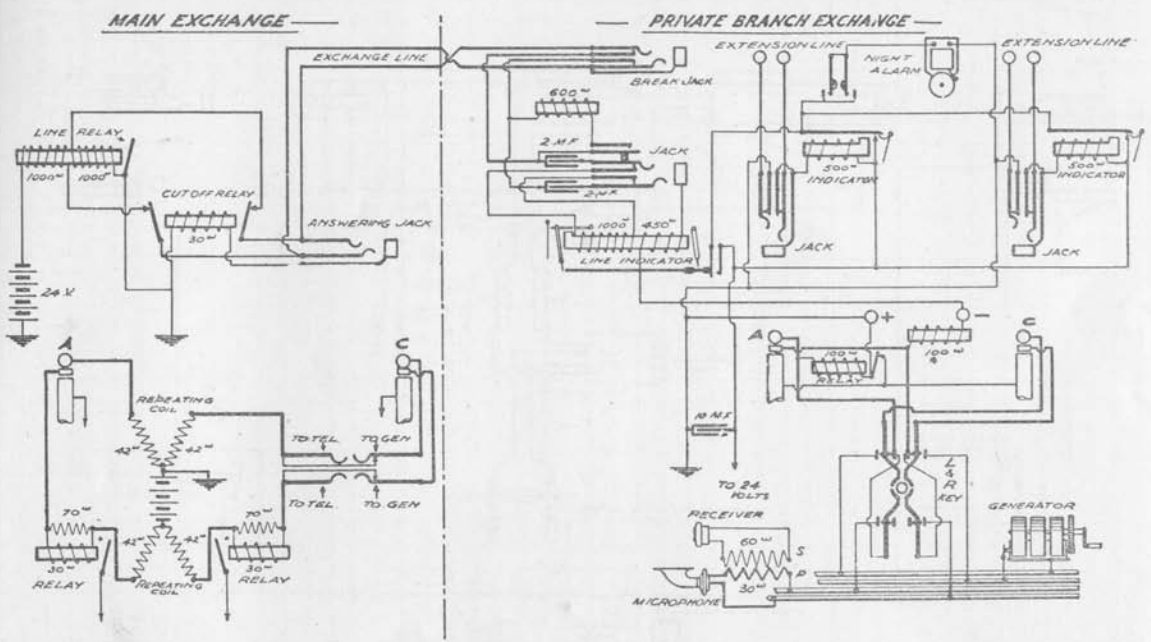


Diagram 61.

C.B P.B.X WITH EYE BALL INDICATOR W.E. TYPE

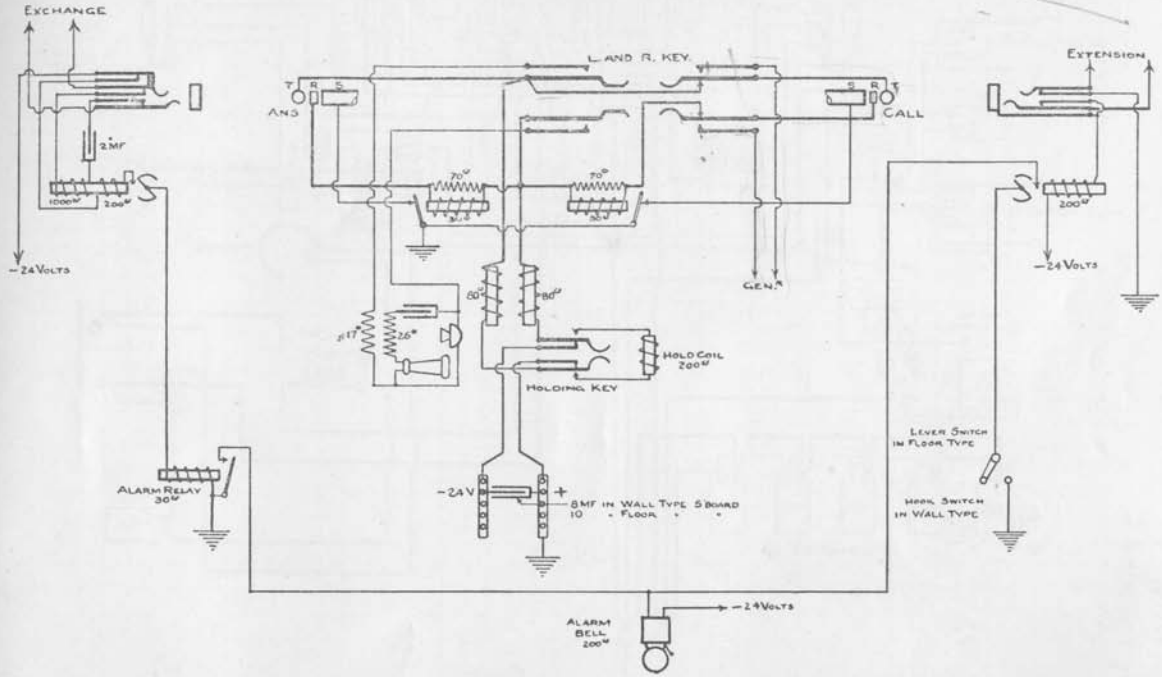


Diagram 62.

C.B P.B.X WITH DROP INDICATOR
W.E TYPE

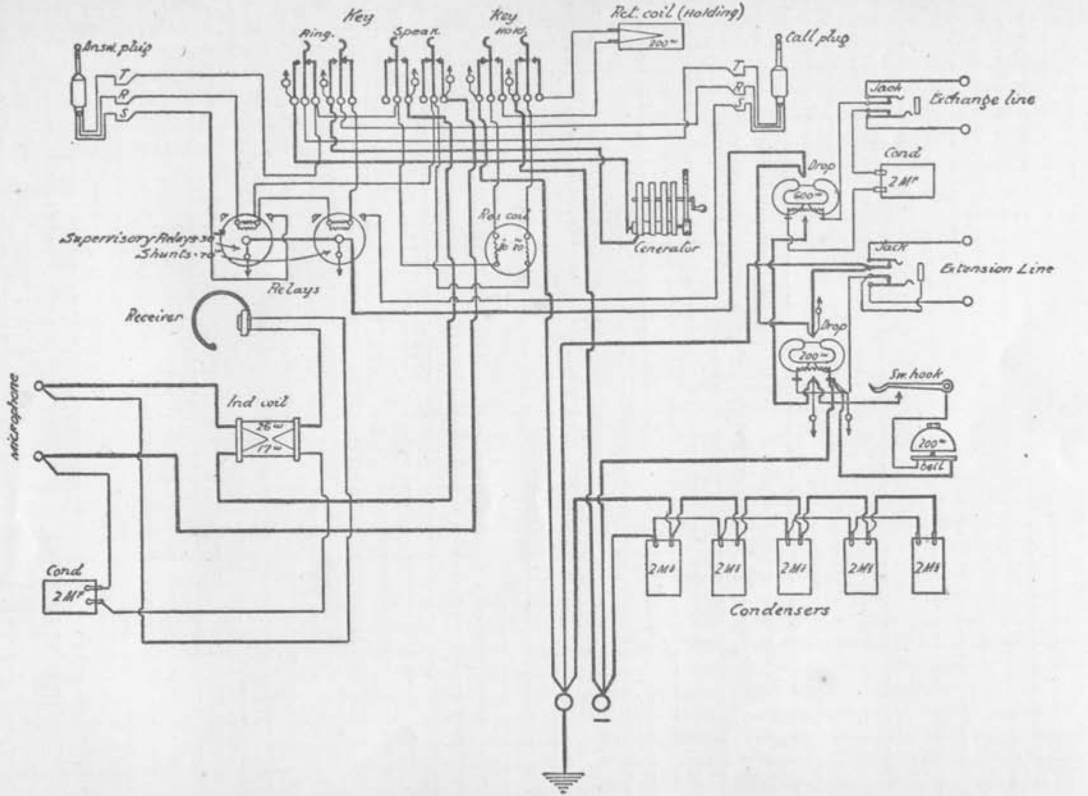


Diagram 63.

Part III.—Trunk Lines.

SECTION 1.

Magneto Trunk Line Circuits.

MAGNETO TRUNK LINE SYSTEMS

FIG. 1

Simple Magneto Trunk

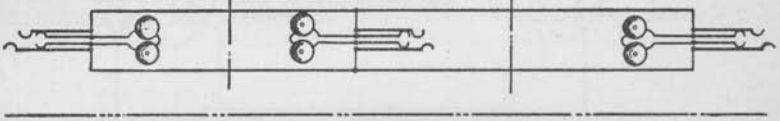


FIG. 2

Magneto Trunk with Telegraph Superimposed

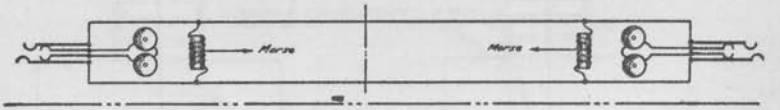


FIG. 3

Metallic Phantom on Two Magneto Trunks

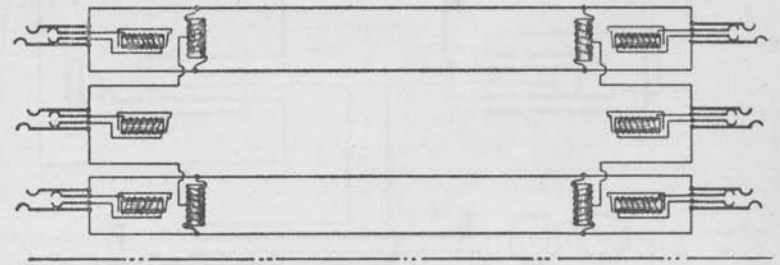


FIG. 4

Earth-Return Phantom on a Magneto Trunk

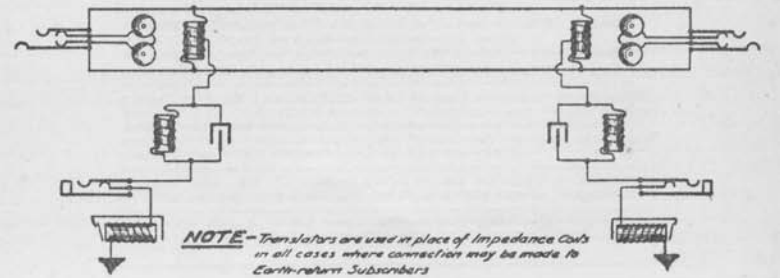
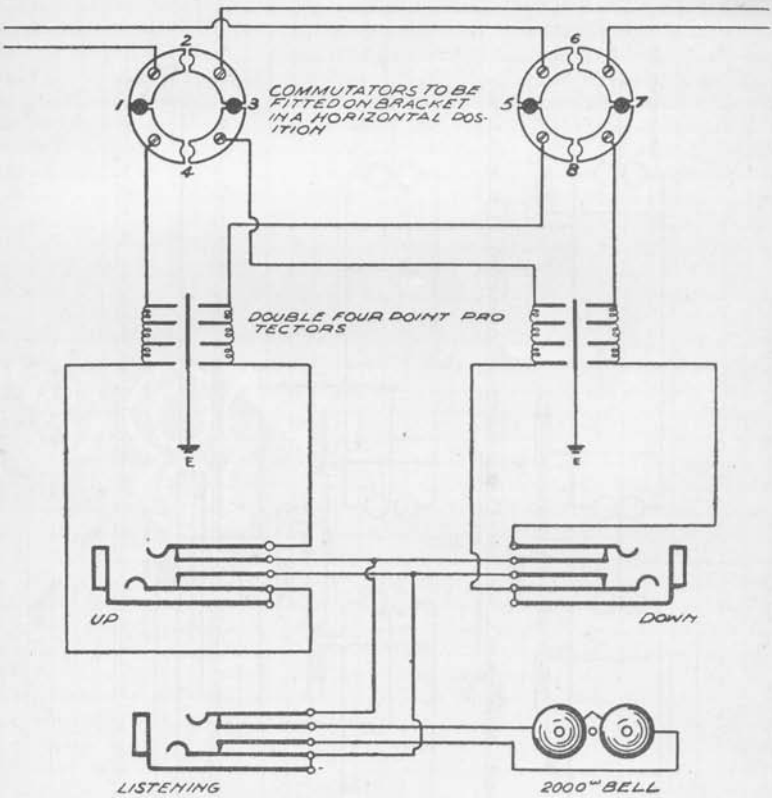


Diagram 64.

INTERMEDIATE TRUNK LINE STATION CONNECTIONS



NOTES

TO JOIN LINES THROUGH CLEAR OF OFFICE, PLUG UP ONLY HOLES 2 AND 6 OF CIRCULAR COMMUTATORS.
TO OPEN CIRCUIT EITHER SIDE OF LINE, INSERT BLACK EBONITE PLUG IN CORRESPONDING JACK.
TO SHORT CIRCUIT EITHER SIDE OF LINE, INSERT SHORT CIRCUITING PLUG IN CORRESPONDING JACK.

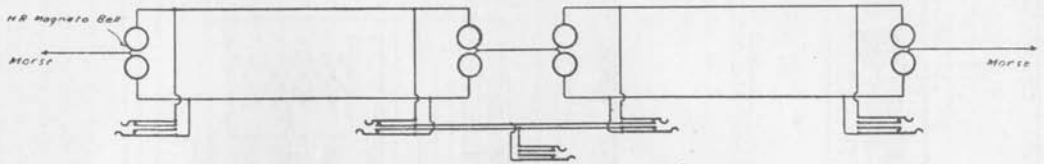
CARE IS TO BE EXERCISED THAT PLUGS ARE NOT INADVERTENTLY LEFT IN JACKS WHEN NOT REQUIRED TO BE THERE, AND THAT THE UP AND DOWN JACKS ARE NEVER USED EXCEPT IT IS FIRST KNOWN (BY PLUGGING IN THE LISTENING JACK) THAT THE TRUNK LINE IS DISENGAGED.

A 2 MF ROLLED CONDENSER IS TO BE PLACED IN SERIES IN THE RECEIVER CIRCUIT OF THE OPERATING TELEPHONE

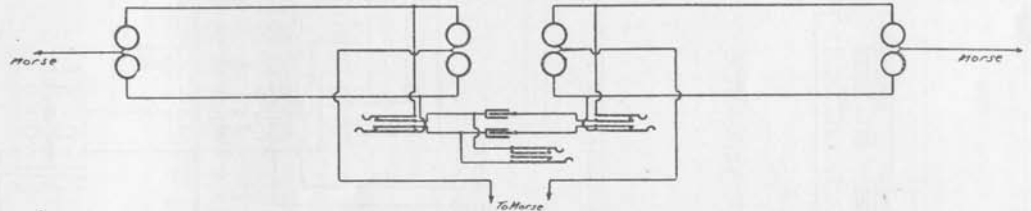
EBONITE PLUG TO BE PROVIDED FOR OPEN-CIRCUITING, ALSO PLUG WITH TIP AND BODY CONNECTED FOR SHORT-CIRCUITING

Diagram 65.

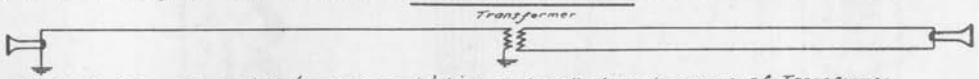
TRUNK LINE CIRCUITS VARIOUS



Trunk Line with Telegraph superimposed - Connections for dividing switches at intermediate station

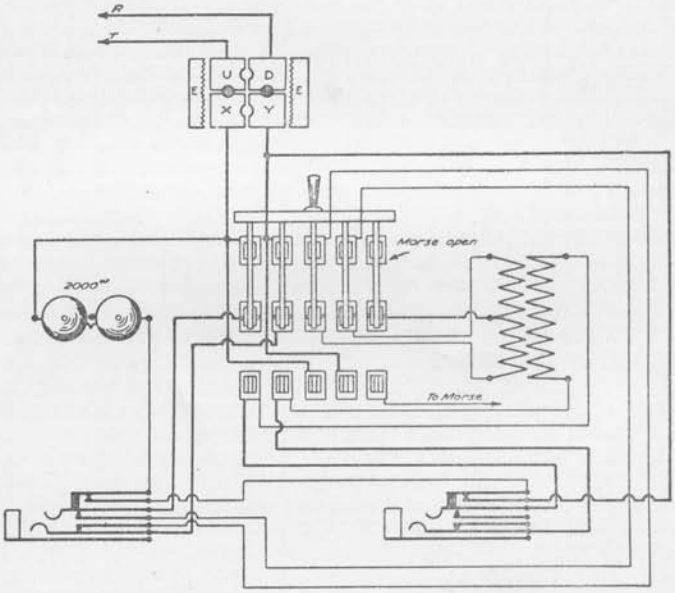


Trunk Line with Telegraph superimposed - Connections for dividing switches at intermediate Stn where Morse installed



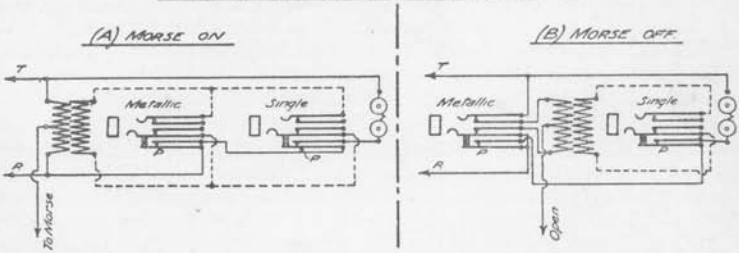
Method of connecting Single (earthed circuit) Line to Metallic Line by means of Transformer

TRUNK LINE WITH MORSE SUPERIMPOSED
TERMINAL STATION CONNECTIONS.



KNIFE SWITCH IN POSITION, METALLIC CIRCUIT, MORSE OPEN.

SCHEMATIC CONNECTIONS



NOTE:- When a Plug is inserted in each of the Jacks, Contacts 'P' open.

Diagram 67.

SECTION 2.

Condenser Trunk Line Circuits.

SYDNEY MELBOURNE TRUNK AT MELBOURNE

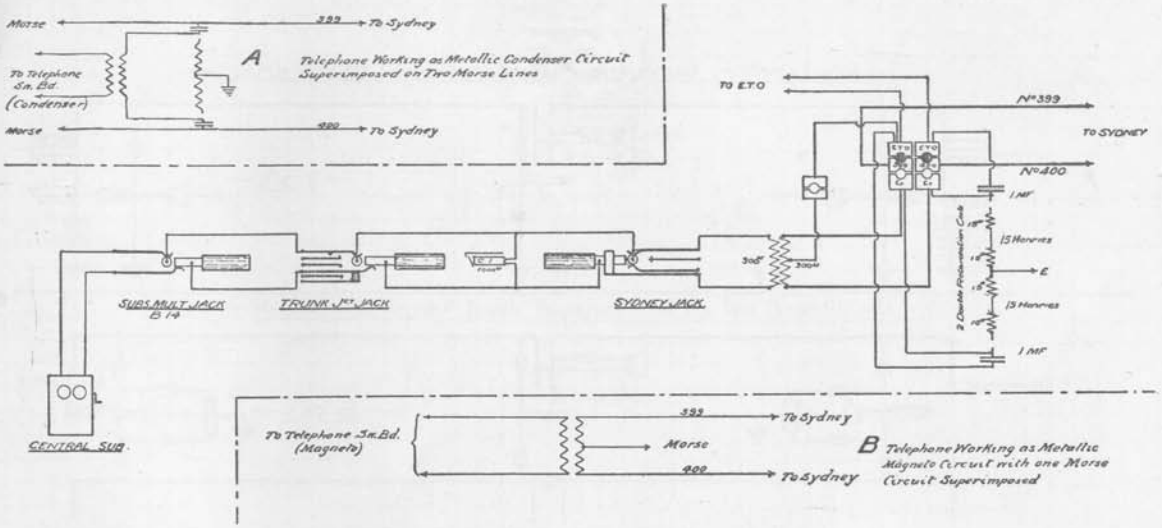
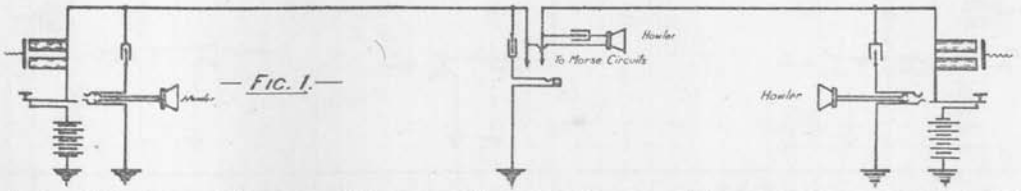


Diagram 68.

CONDENSER TRUNK LINE SYSTEMS

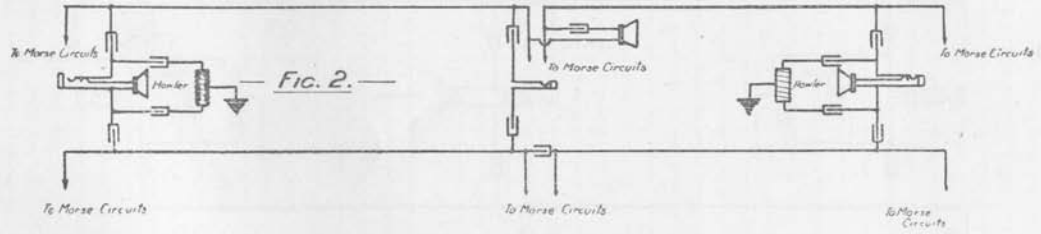
Diagram 69.

— Earth-Return Condenser Trunk Superimposed on Morse Circuit —



— FIG. 1. —

— Metallic Condenser Trunk Superimposed on Two Morse Circuits —



— FIG. 2. —

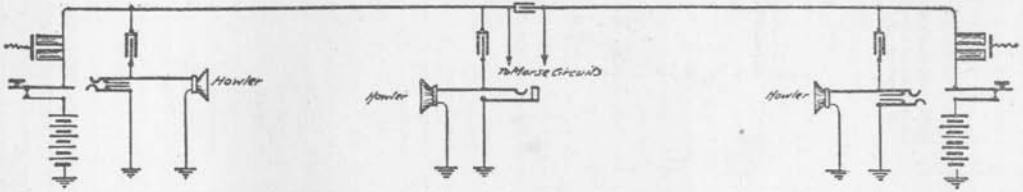
CONDENSER TRUNK LINE SYSTEM SA

Diagram 70.

231

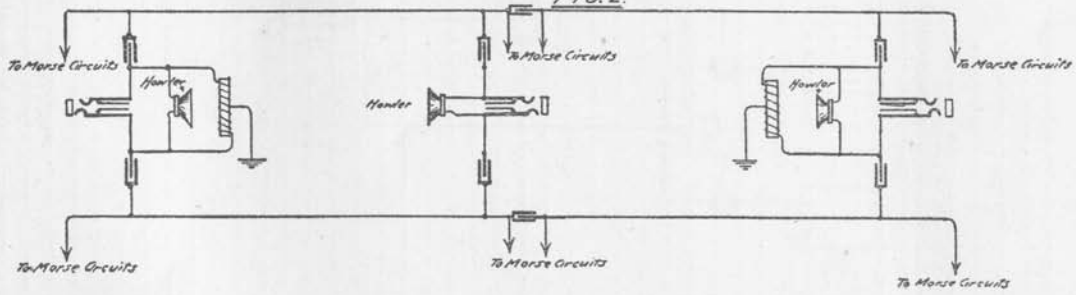
Earth-Return Condenser Trunk Superimposed on Morse Circuit.

FIG. 1.



Metallic Condenser Trunk Superimposed on Two Morse Circuits.

FIG. 2.



CONDENSER TELEPHONE STATION

SINGLE LINE, INTERMEDIATE,

WITHOUT MORSE

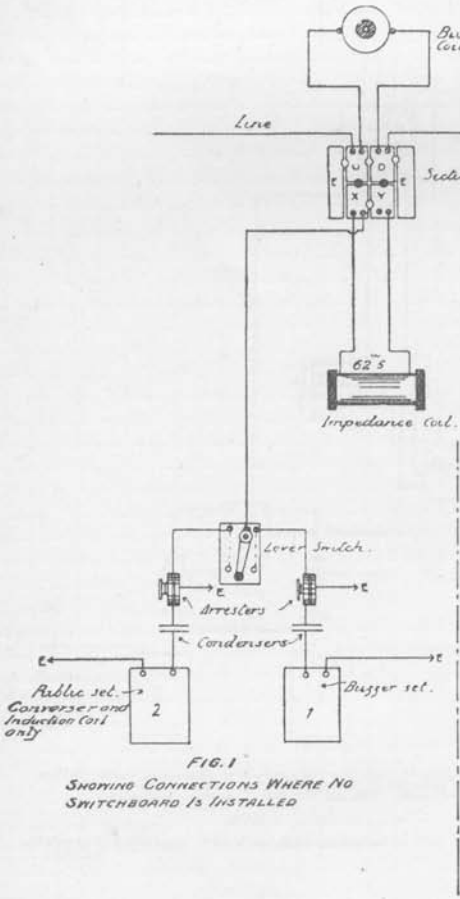


FIG. 1

SHOWING CONNECTIONS WHERE NO SWITCHBOARD IS INSTALLED

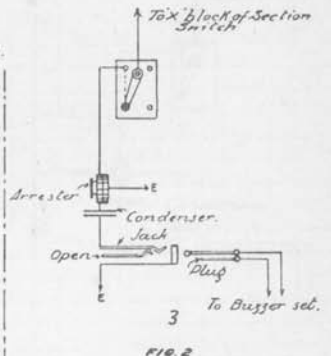


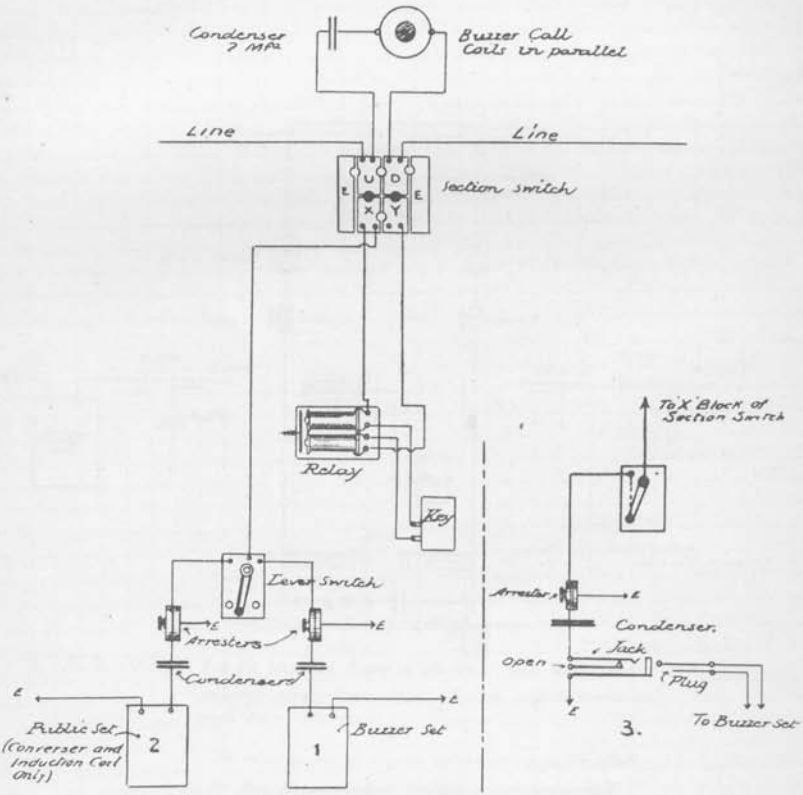
FIG. 2

LINE TERMINATED ON SWITCHBOARD EQUIPPED WITH REGULAR CORD AND SUBSCRIBERS LINE CIRCUITS

Diagram 71.

CONDENSE TELEPHONE STATION

SINGLE LINE INTERMEDIATE



NOTE: Where capacities of Condensers are not shown, the capacities are determined by testing what is required for any effective service. Min.m 1/4 Mf. Max.m 1 Mf.

FIG. 1

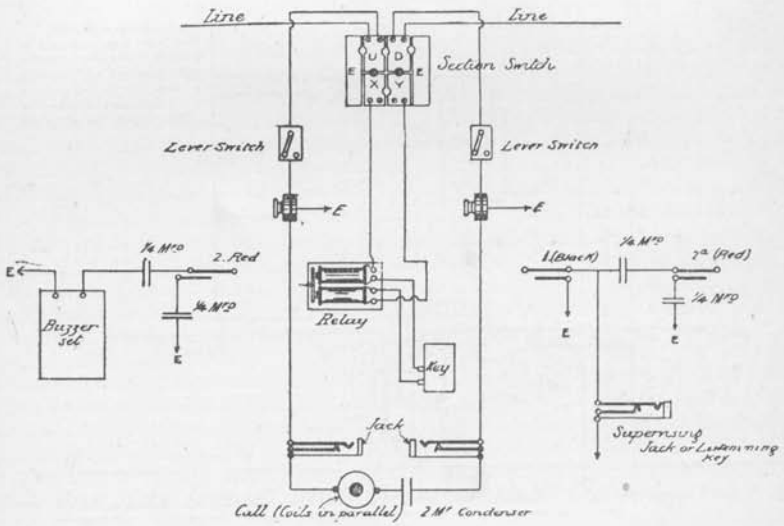
Showing Connections Where no Switchboard is Installed.

FIG. 2

Line Terminated on Switchboard Equipped with Regular Cord and Subscribers' Line Circuits

Diagram 72.

CONDENSER TELEPHONE STATION SINGLE LINE, INTERMEDIATE EQUIPPED FOR DIVIDING THE TELEPHONE CIRCUIT

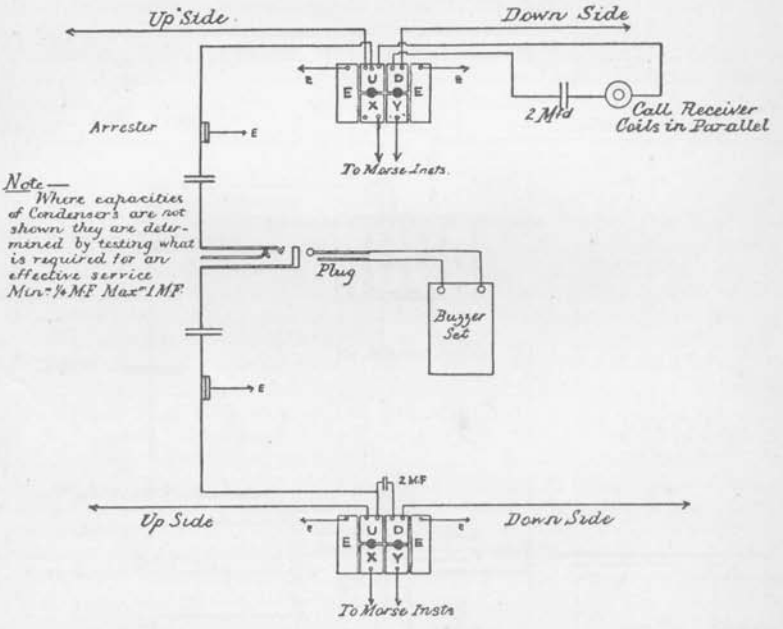


Note:- Plugs 2 & 2a should have a distinct and different colored cover from that of plug 1. This provision will save confusion.

The arrangement shewn above is suitable also for Non-Morse Station bridging condenser not required

Diagram 73.

CONDENSER TELEPHONE STATION
METALLIC LINE INTERMEDIATE



— One Side looped and the other teed in —

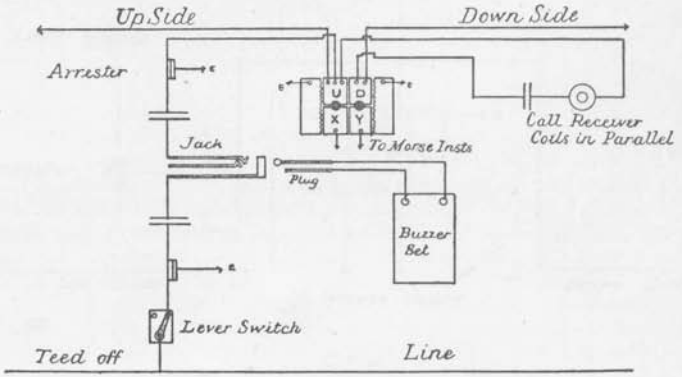


Diagram 74.

CONDENSER TELEPHONE STATION
METALLIC LINE TERMINAL

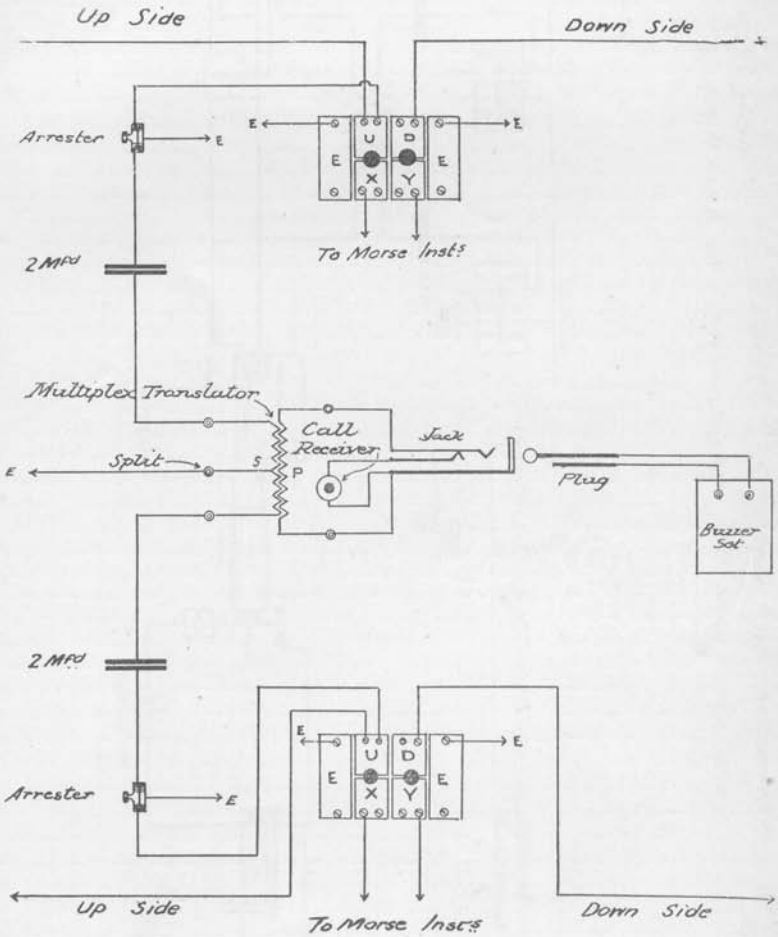


Diagram 75.

CONDENSER TELEPHONE STATION METALLIC LINE
TERMINATED ON SWITCHBOARD FOR NIGHT SERVICE

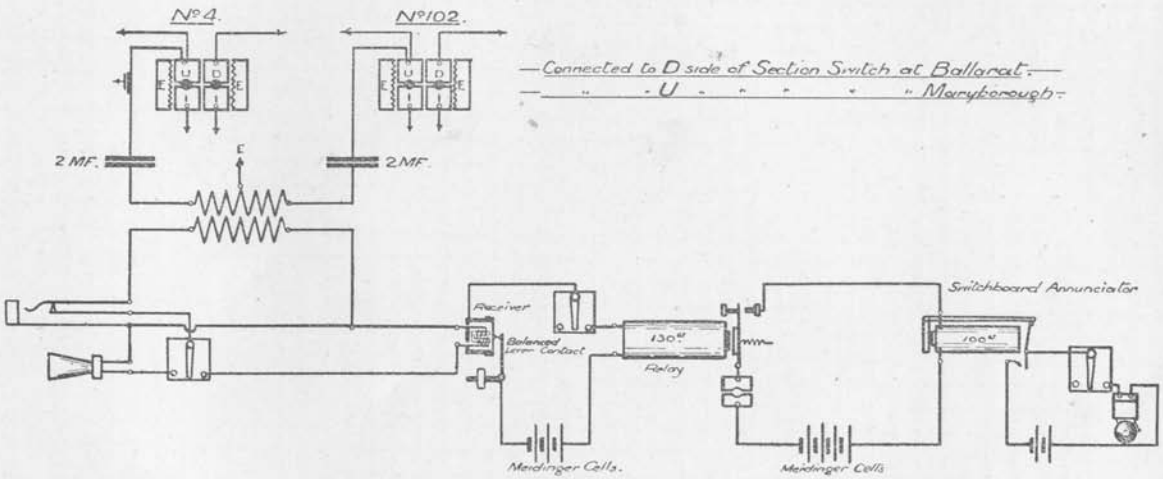


Diagram 76.

Part IV.—Miscellaneous.

SECTION 1.

Telephone Circuits.

IMPROVED CONNECTIONS FOR MAGNETO TELS WORKING ON CB SYSTEMS.

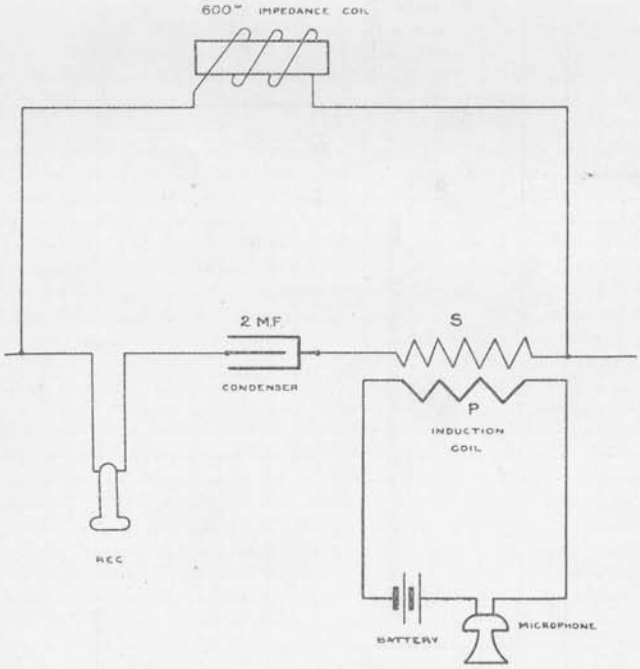


Diagram 77.

TELEPHONE C.B. MAIN & AUXILIARY, To receive calls on Auxiliary set No intercommunication.

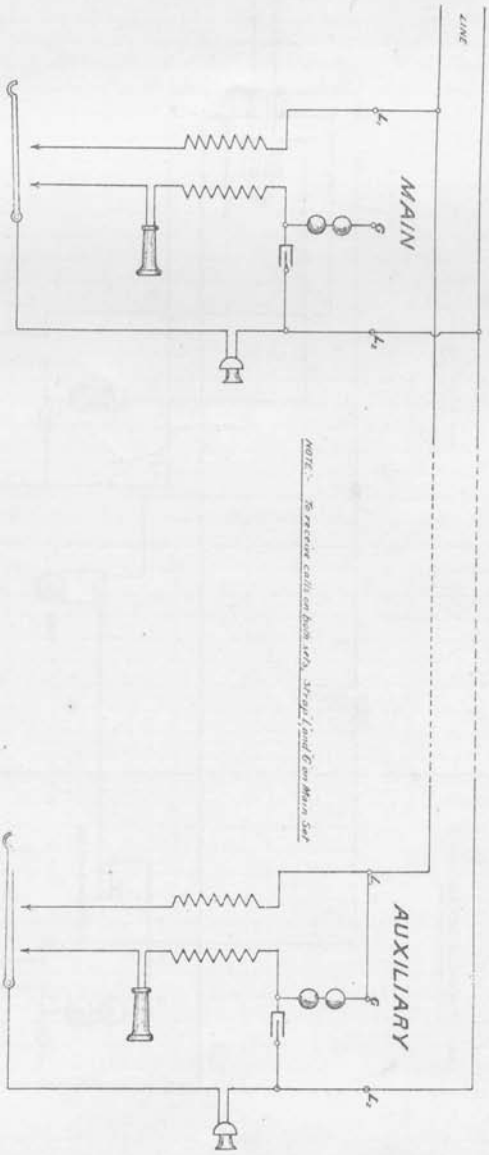


Diagram 78.

— SIMPLE EXTENSION CIRCUIT WITH SECRECY SWITCH AT MAIN — CALLS NORMALLY RECEIVED ON AUXILIARY SET —

PRESS BUTTON AND BELL FOR CALLING MAIN FROM AUXILIARY WHEN REQUIRED

Diagram 78a.

TELEPHONE C.B. MAIN & AUXILIARY, using one coil and Condenser no intercommunication.

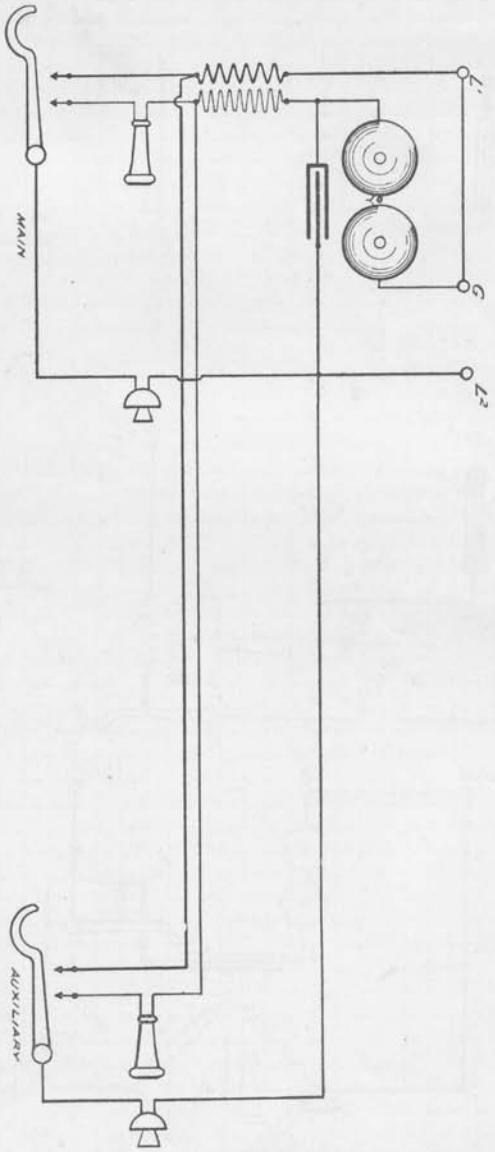


Diagram 79.

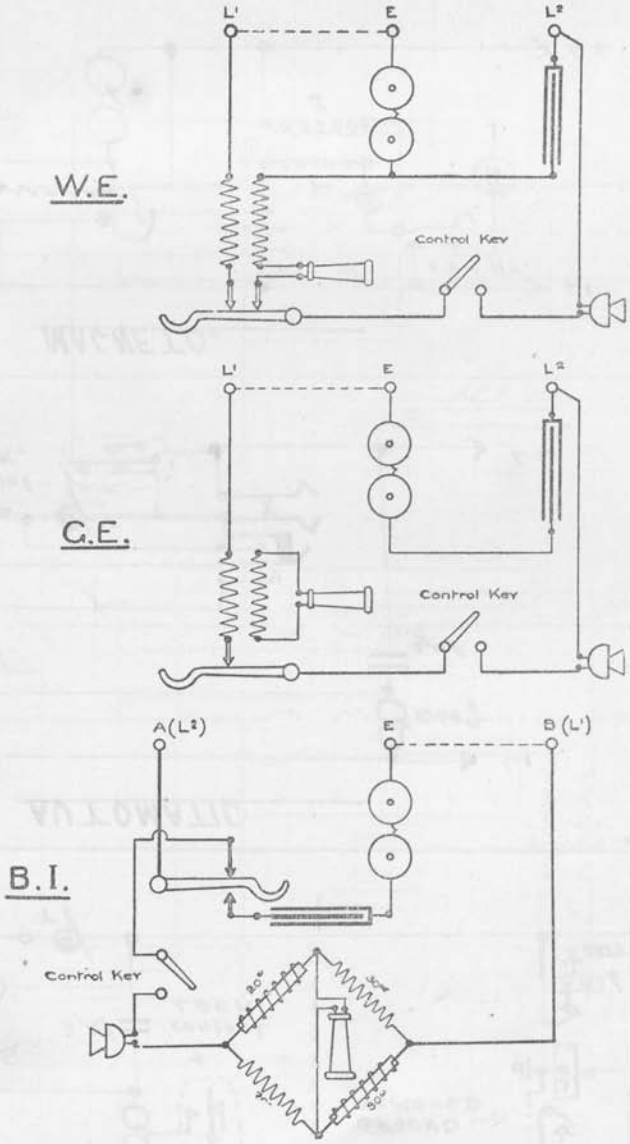
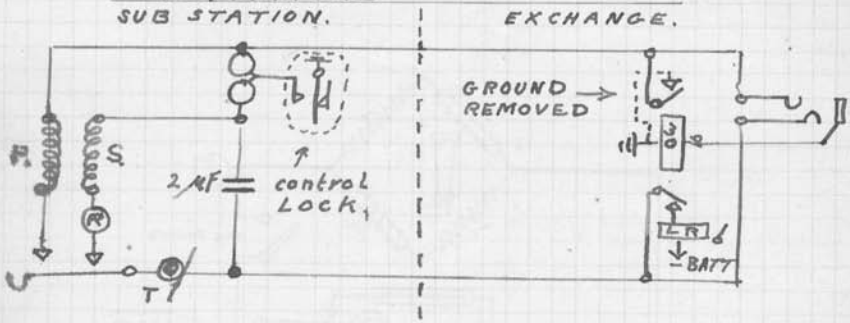

W.E.
L¹
E
L²
Control Key
G.E.
L¹
E
L²
Control Key
B.I.
A(L²)
E
B(L¹)
Control Key
20
20

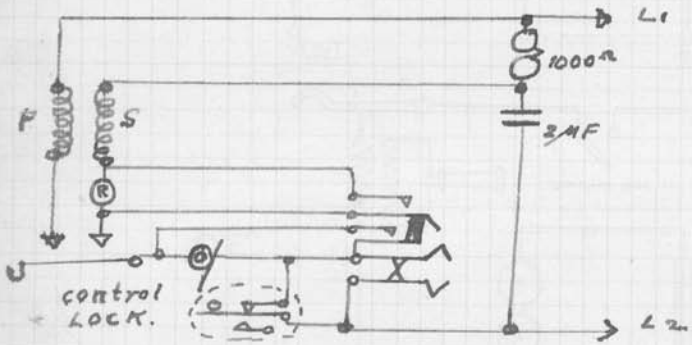
Diagram 80.

CONTROL LOCKS.

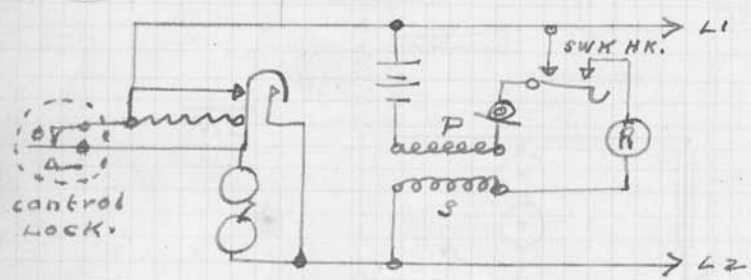
C.B. MANUAL



AUTOMATIC



MAGNETO.



TELEPHONES C.B. TAPPER, WITH KEYS.

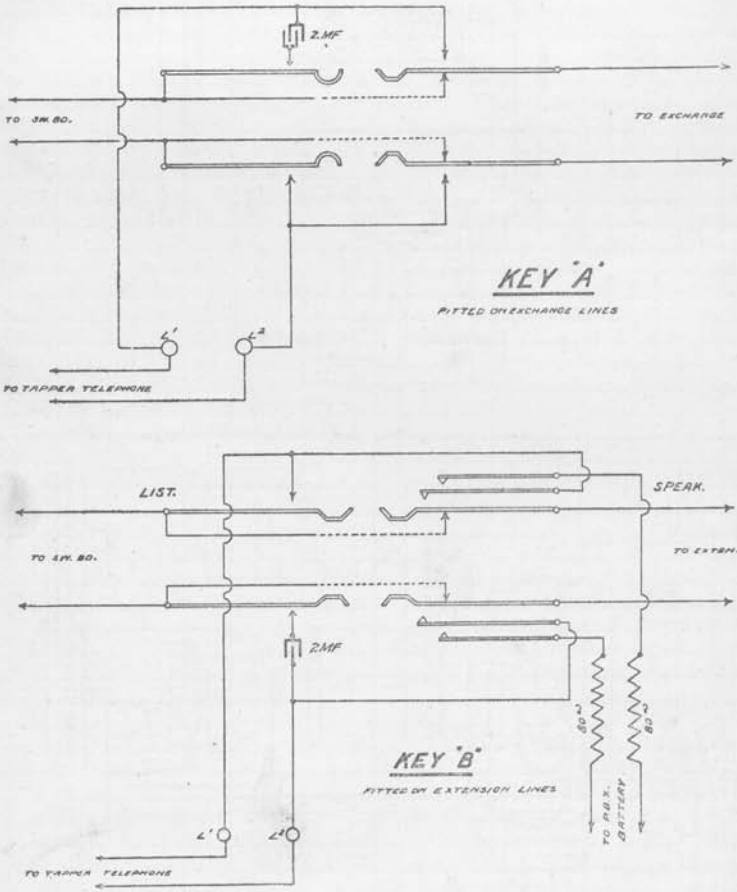


Diagram 81.

TELEPHONE STATIONS C.B. MAIN & EXTENSION METHOD OF WIRING.

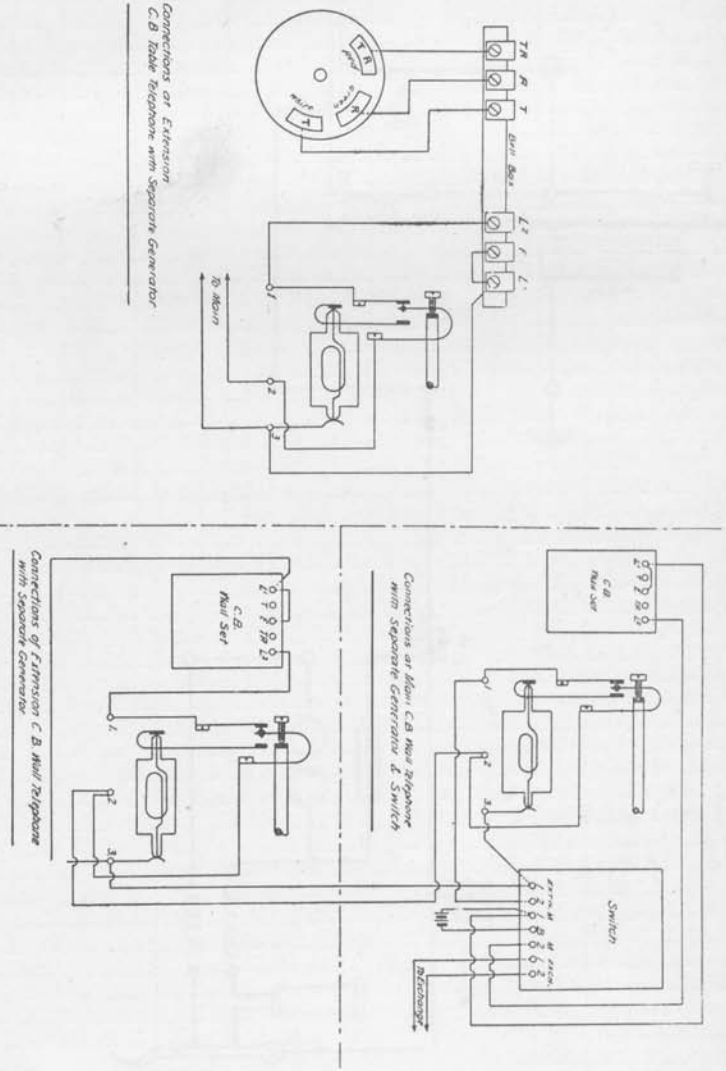


Diagram 82.

TELEPHONE C.B. METHOD of Connecting
Ericsson Party Line Register Co.

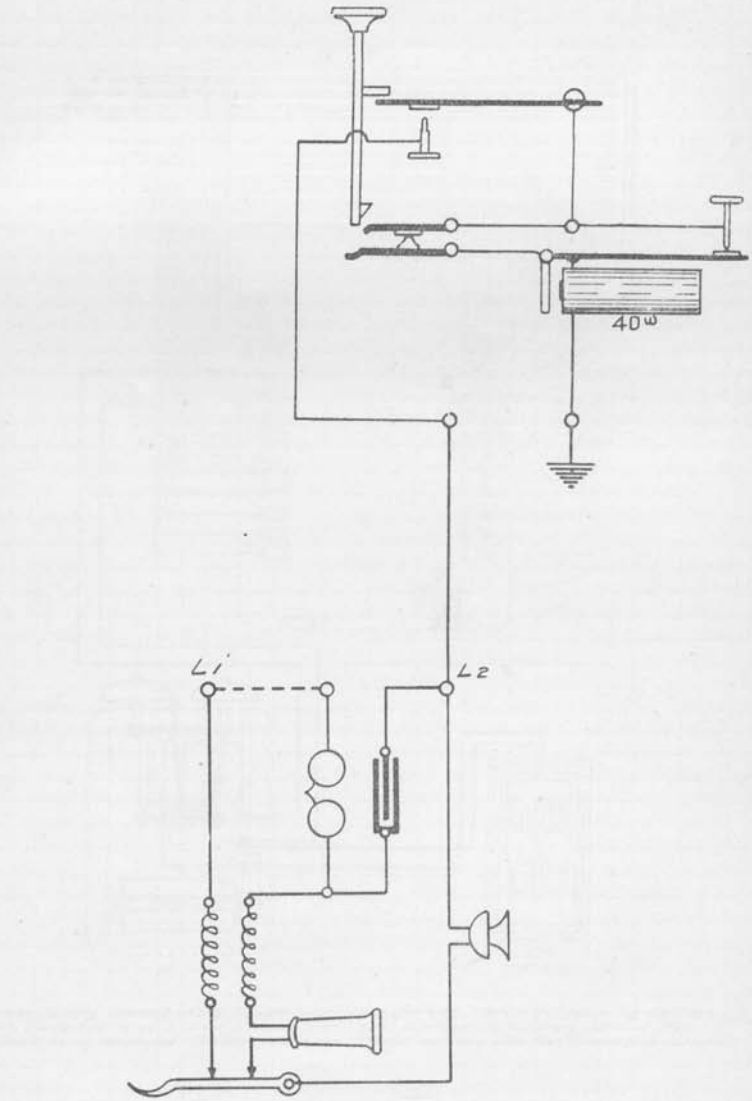


Diagram 83.

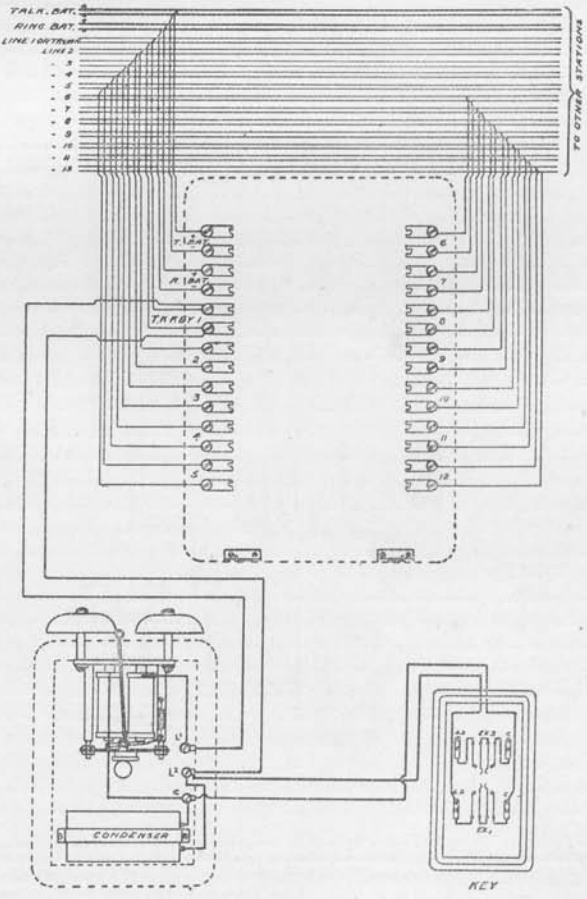


Diagram shewing connections of Apparatus at Transferring Station for securing Central Battery Exchange Service in conjunction with Local Intercommunicating Service, Wall Telephone being employed. Connections shew Eleven Stations and One Trunk Line wired in.

Diagram 84.

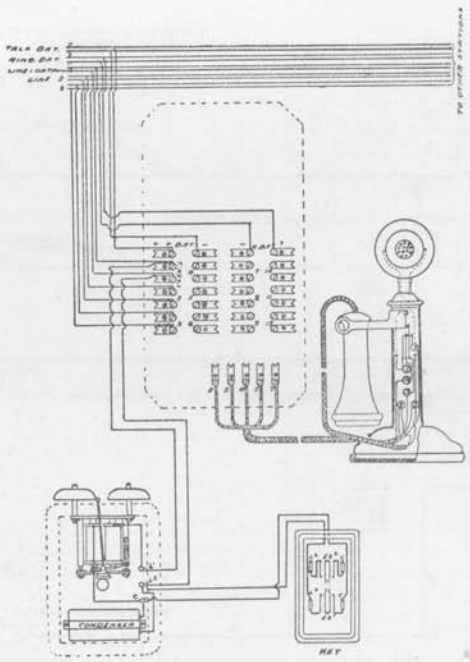
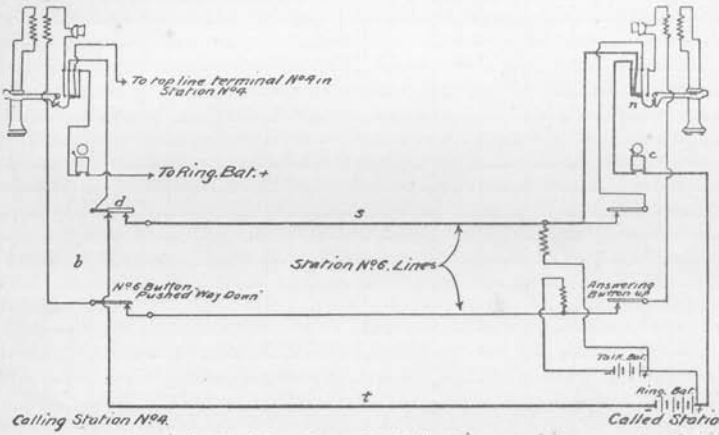


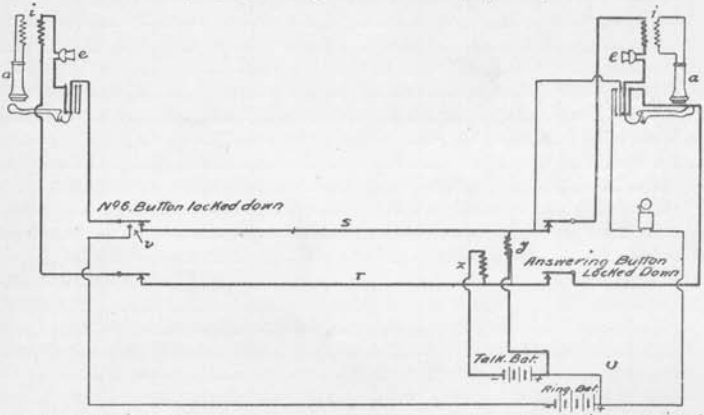
Diagram shewing connections of Apparatus at Transferring Station for securing Central Battery Exchange Service in conjunction with Local Intercommunicating Service, Desk Telephone being employed. Connections shew Two Local Lines and One Trunk wired in. The Other Local Lines may be connected in same Manner as Line 2 or Line 3.

Diagram 85.

INTERCOMMUNICATING SYSTEM C.B. W.E. No 2.
TELEPHONE CIRCUITS [SCHEMATIC.]



Circuits Involved when a Party at One Station Rings up a Party at another Station



Circuits involved when Two Parties are conversing over an Intercommunicating System

Diagram 86.

SECTION 2.

Switchboard Circuits.

MAGNETO SWITCHBOARD. P.B.X Fitted with Condensers for C.B. Service.

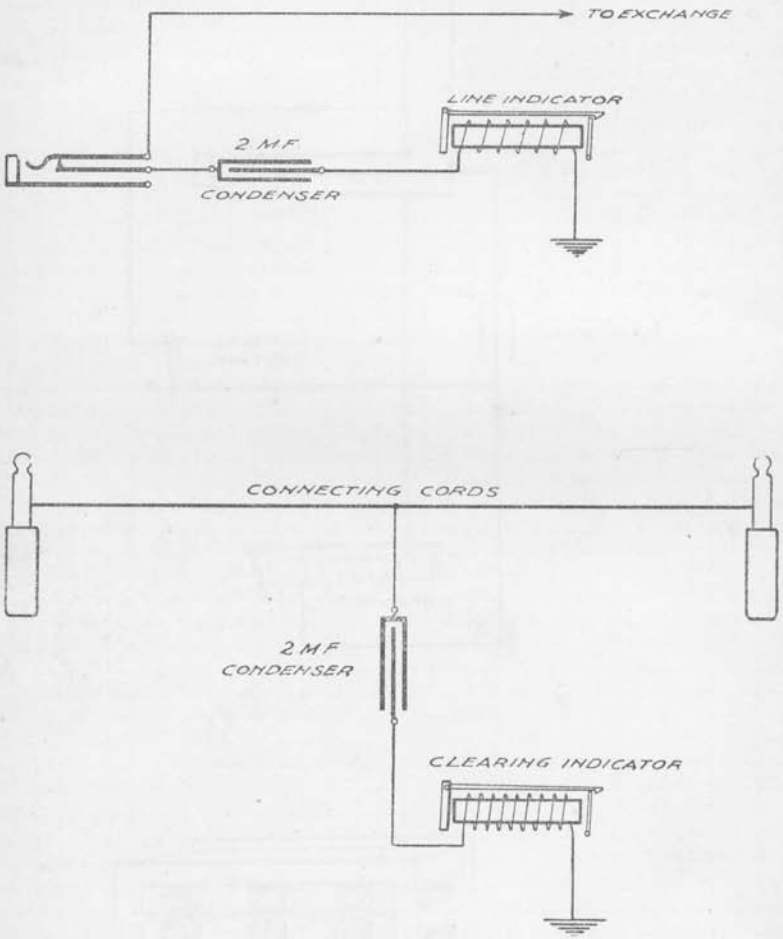
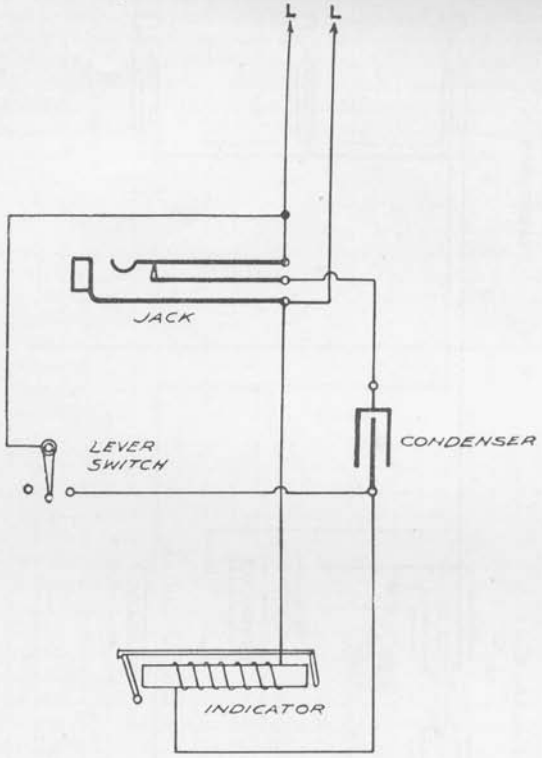


Diagram 87.

MAGNETO SWITCH BOARD. P.B.X Fitted with Holding Coil for C.B. Service.



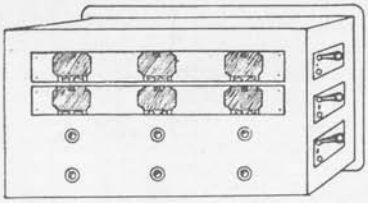


Diagram 88.

Magneto Switchboards. Earthed circuit
Transfer Circuit (one way) for.

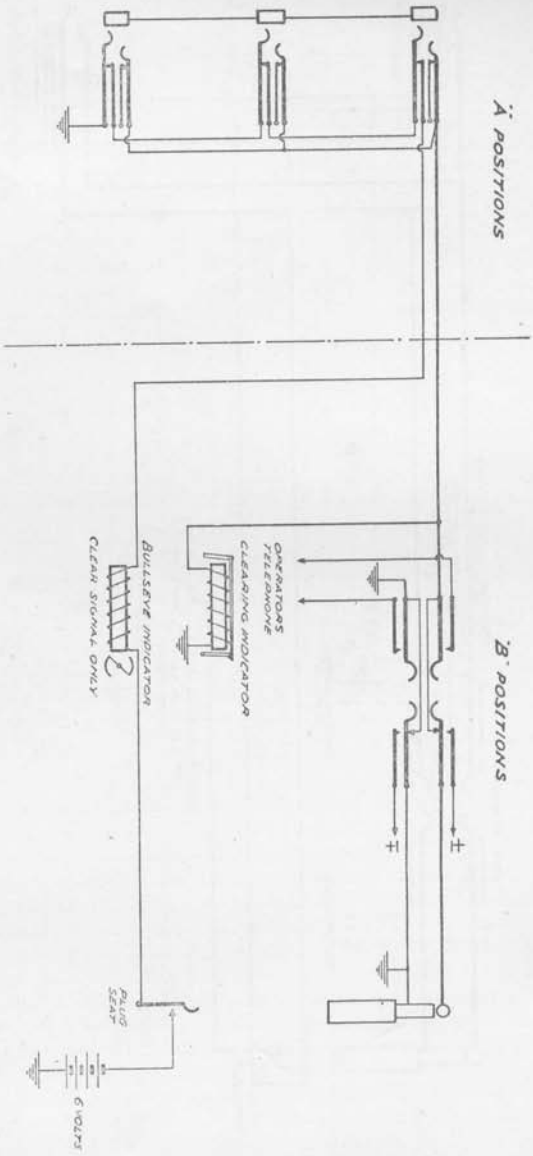


Diagram 89.

MAGNETO SWITCH BOARDS. METALLIC CIRCUIT TRANSFER CIRCUIT (ONE WAY) for

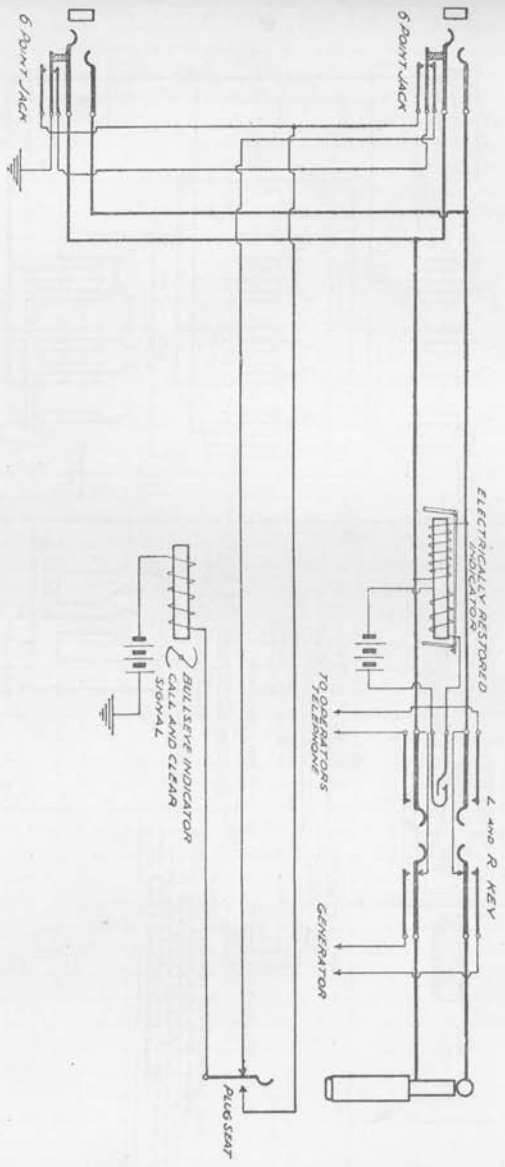


Diagram 90.

SWITCHBOARD C.B. Cordless adapted for working on Automatic Systems. P.B.X.

Diagram 91.

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FIG 1 DIAGRAM OF CONNECTIONS

ARRANGEMENT TO DISCONNECT EXCHANGE LINE INDICATOR WHEN LINE IN USE.

FIG 2 SIDE ELEVATION OF KEY

FIG 3 DETAILS OF CONTACTS L

NOTE :- Contacts K & L on each Key are to be mounted side by side in the space available. Contacts K are operated directly by spring B when it is moved upward, while contacts L are actuated by means of the Link when Spring A is moved downward. Contacts K & L are both break contacts.

FIG 4 METHOD OF CONNECTING CALLING DEVICE

SWITCHBOARD C.B. (W.E. No 1).
SUBSCRIBERS LINE CIRCUIT.

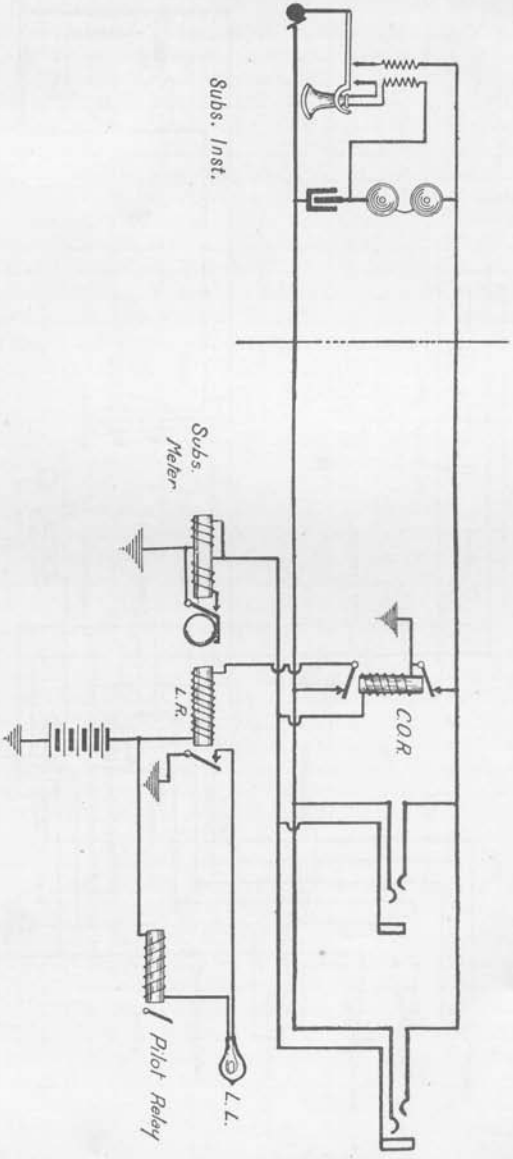


Diagram 92.

SWITCHBOARD C.B. B1 CO.

SUBSCRIBERS LINE CIRCUIT.

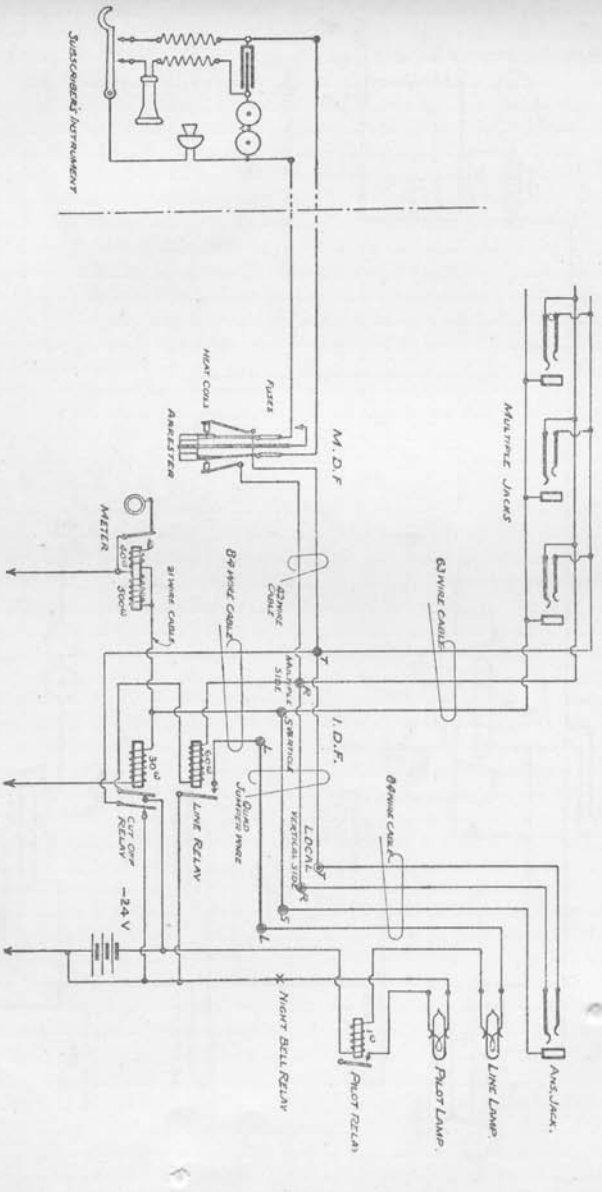


Diagram 93.

SWITCHBOARD C.B. G.E. Coy.
SUBSCRIBERS LINE CIRCUIT.

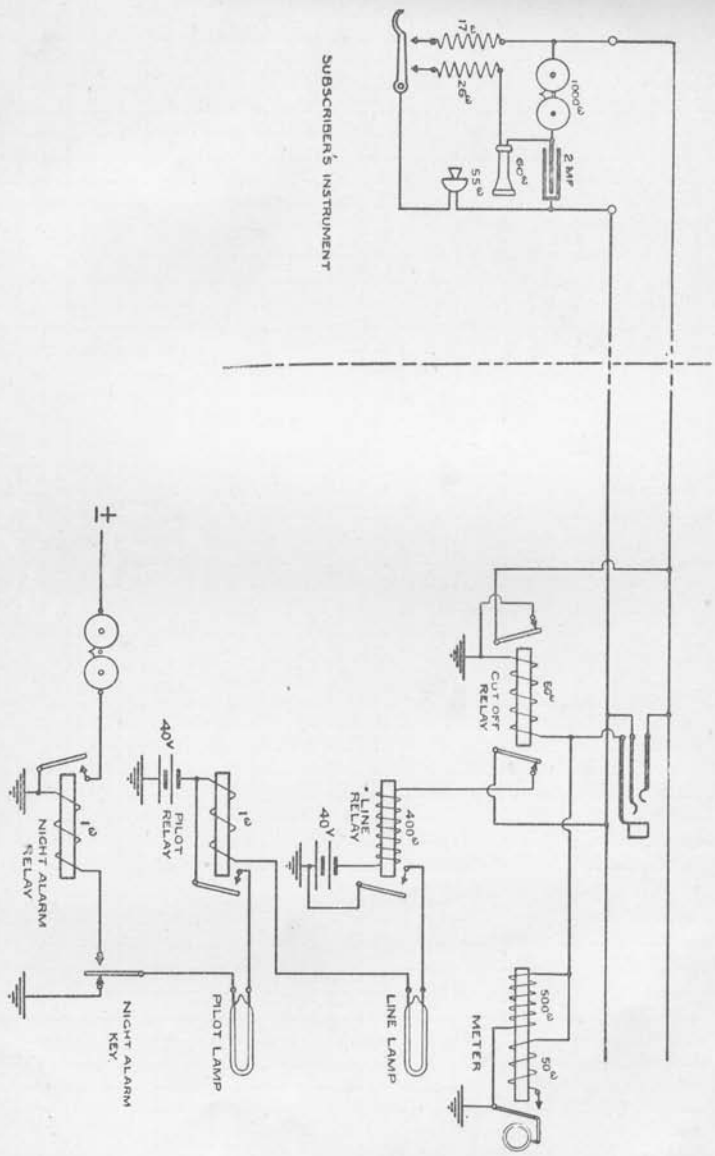


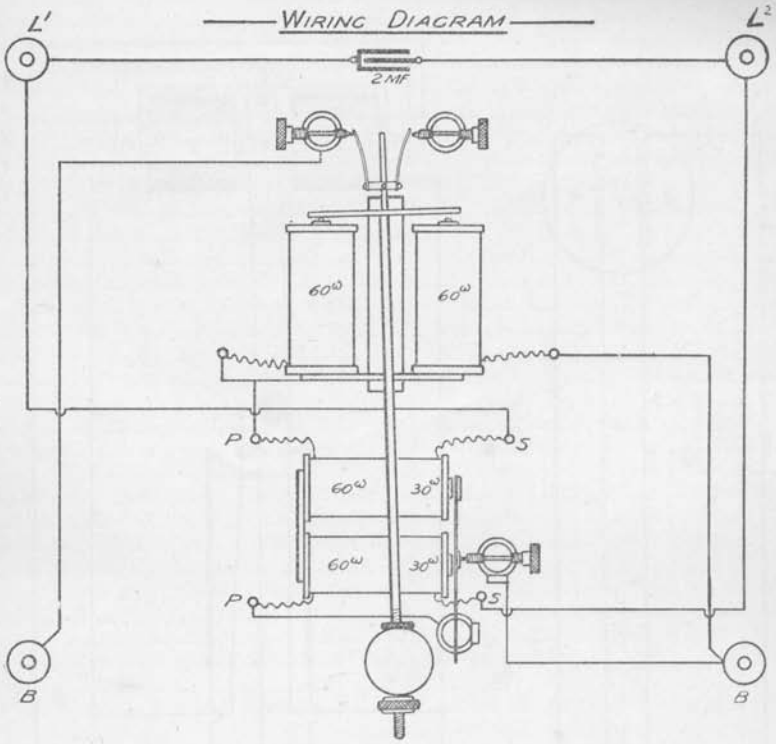
Diagram 94.

SECTION 3.

Apparatus—Various.

BUSY BACK, BATTERY OPERATED.

WIRING & SCHEMATIC CIRCUIT.



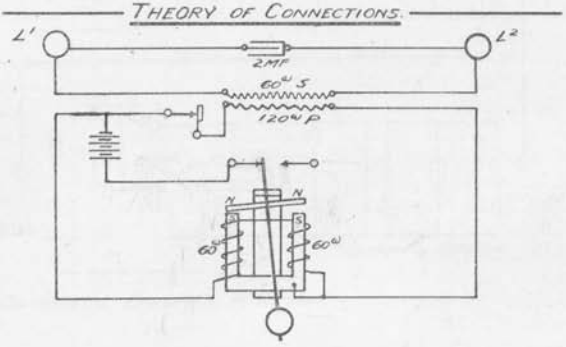
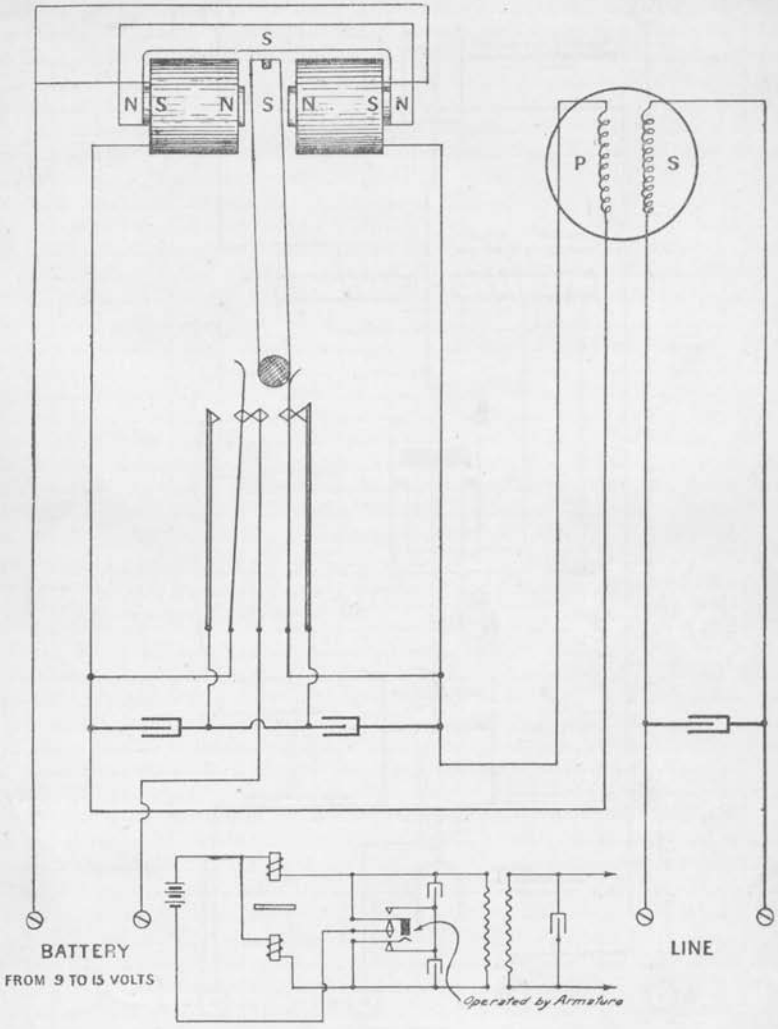


Diagram 95.

Polechanger W. E. No 62.



Schematic Diagram of Circuit

Diagram 96.

POLE changer BATTERY (old Form.)

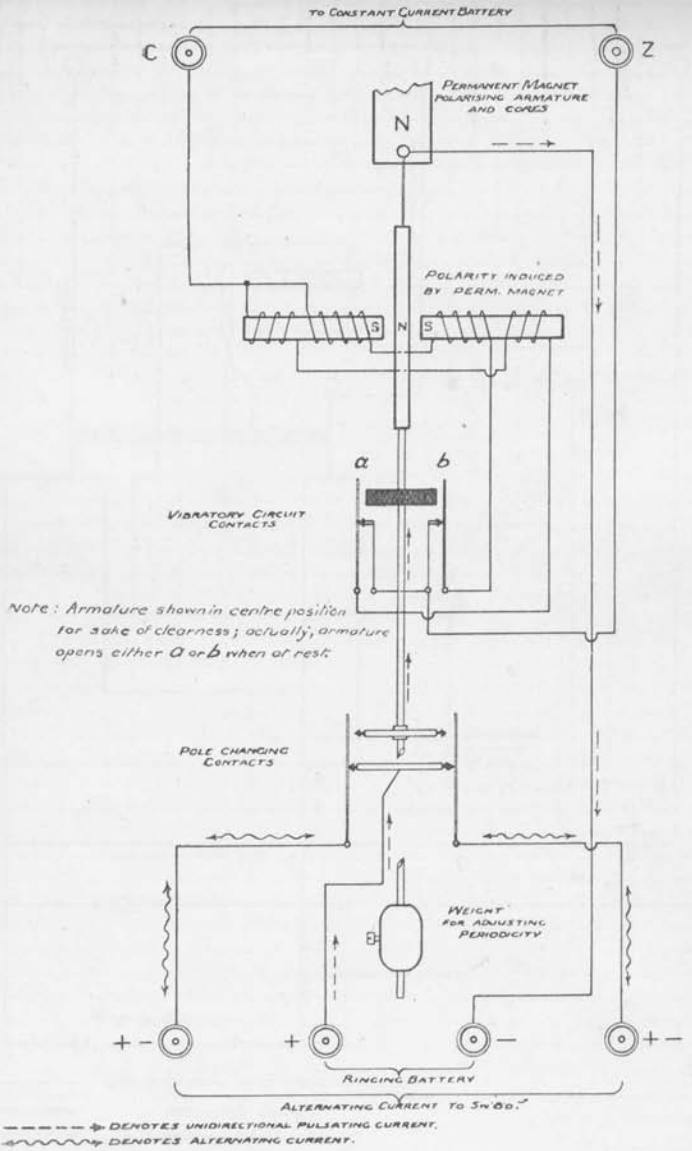


Diagram 97.

POLECHANGER Sandwich Type.

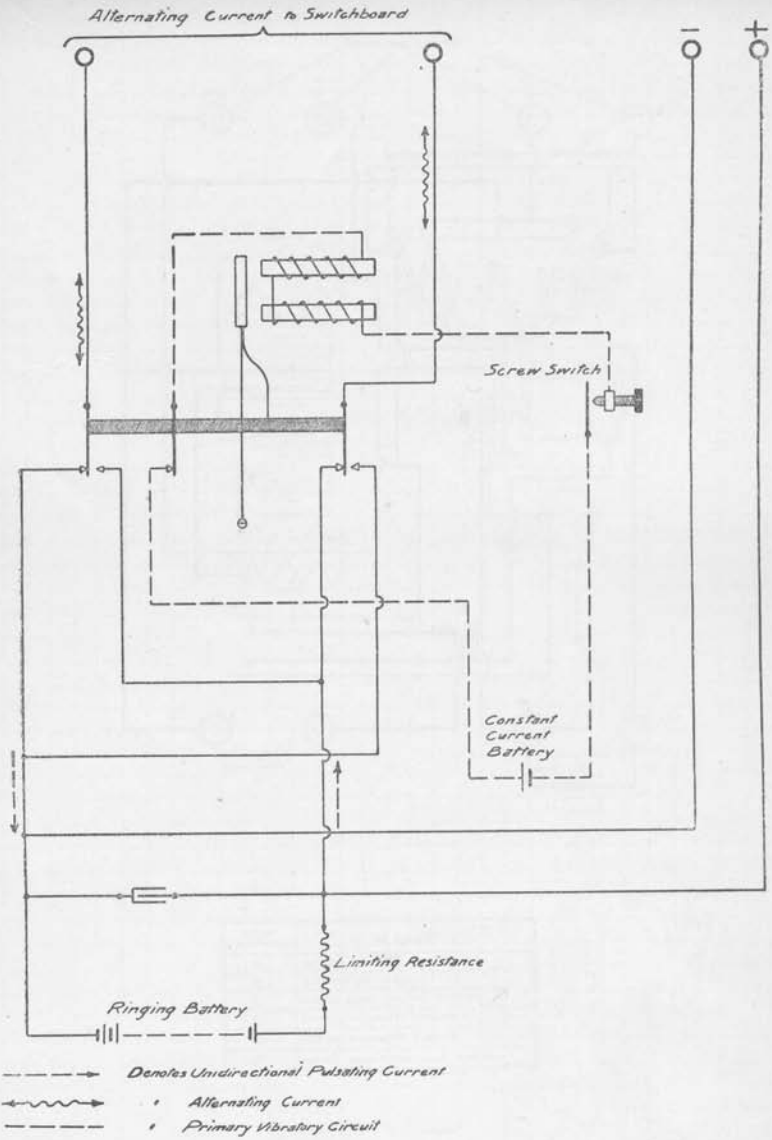
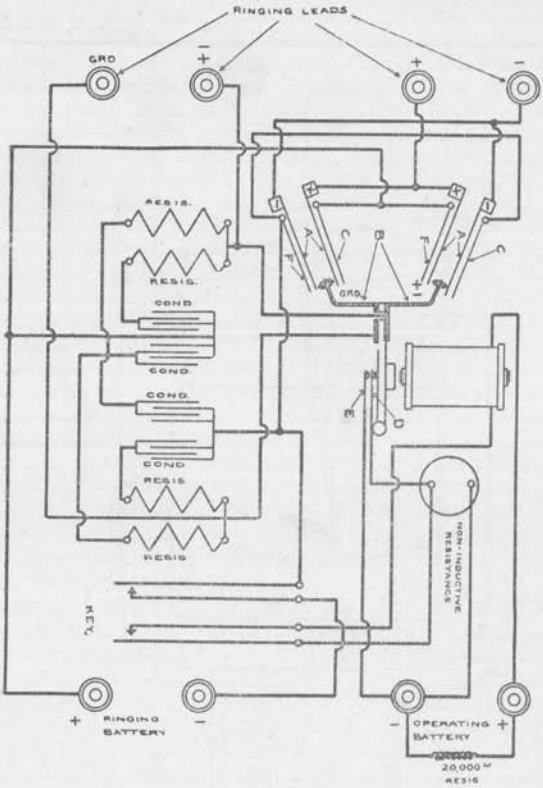


Diagram 98.

POLE CHANGER, BATTERY, WARNER TYPE.



REF. LETTER	NAME
A	UPPER RING[illegible] SPRING
B	VIBRATOR ARM
C	OUTER BACK RINGING SPRING
D	INNER MAGNET SPRING
E	OUTER MAGNET SPRING
F	OUTER FRONT RINGING SPRING

Diagram 99.

POLECHANGER. NOYES, VIBRATORY TRANSFORMER

SCHEMATIC CIRCUIT.

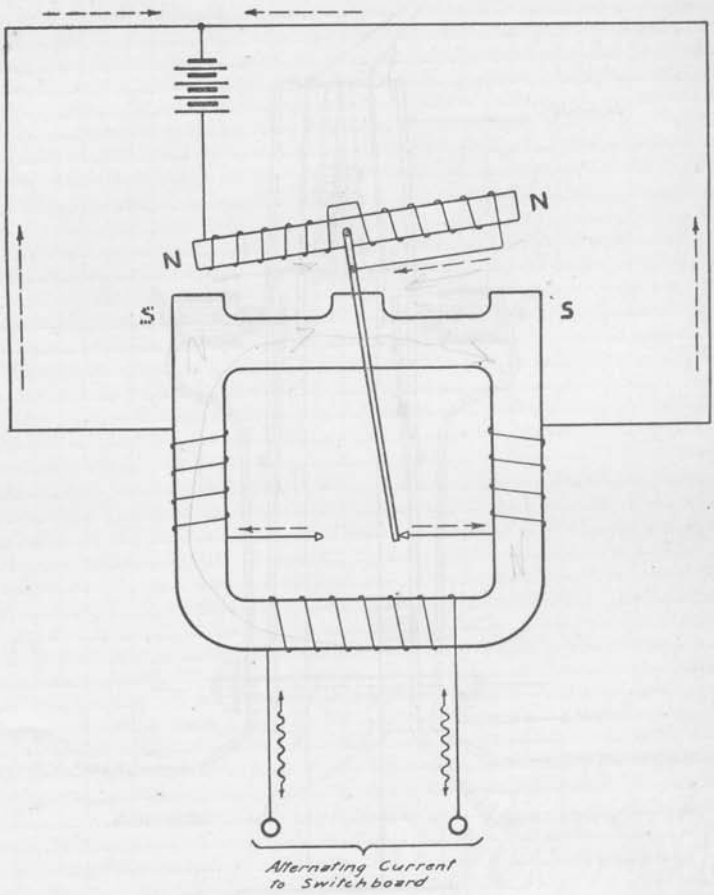
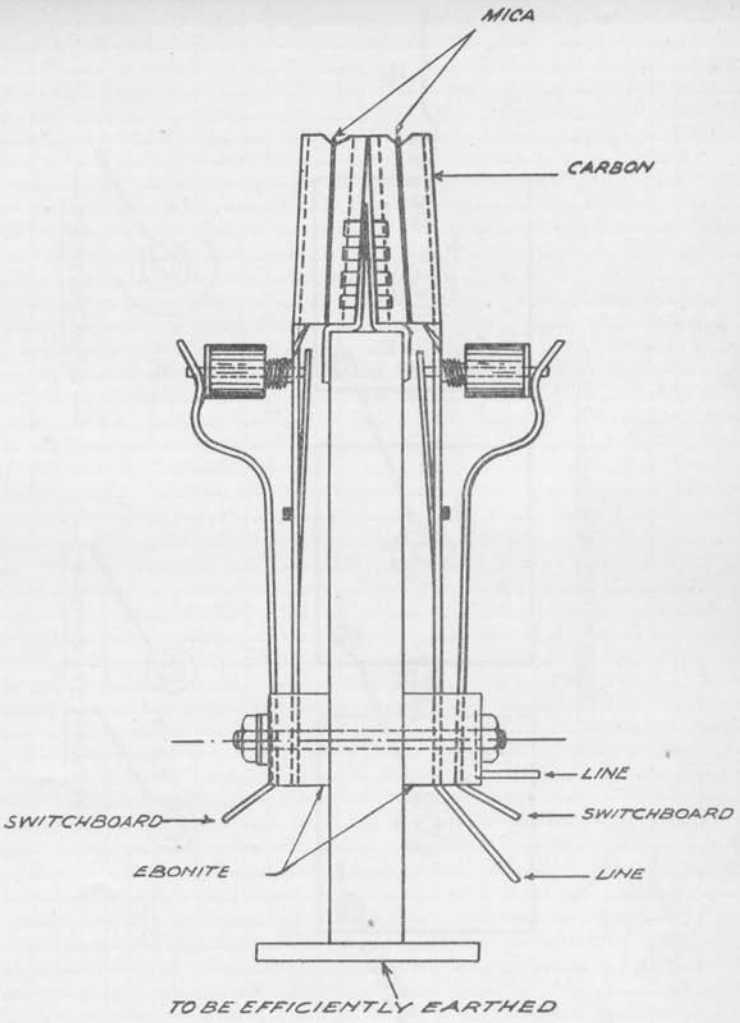


Diagram 100.

PROTECTORS M.D.F. W.E. TYPE.



NOTE:- WHEN FUSES ARE PROVIDED THE LINE IS FITTED DIRECT TO FUSE THEN TO ARRESTER

Diagram 101.

METHOD OF CONNECTING DRY CELLS.

— 3 CELLS CONNECTED IN SERIES —

FIG. 1.

FIG. 2.

— RIGHT METHOD —

FIG. 3.

— WRONG METHODS —

SECTION 4.

Conventional Signs, &c.

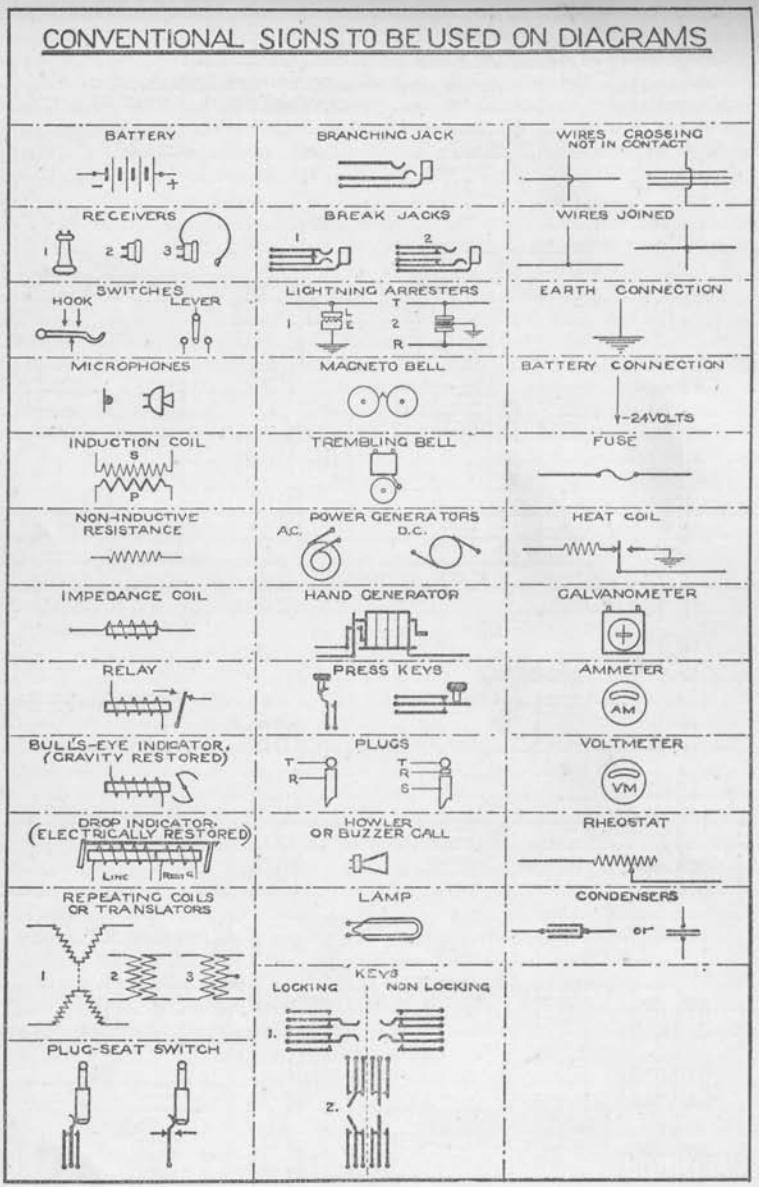

CONVENTIONAL SIGNS TO BE USED ON DIAGRAMS
BATTERY
BRANCHING JACK
WIRES CROSSING NOT IN CONTACT
RECEIVERS
1
2
3
BREAK JACKS
1
2
WIRES JOINED
SWITCHES
HOOK
LEVER
LIGHTNING ARRESTERS
1
E
T
2
R
EARTH CONNECTION
MICROPHONES
MAGNETO BELL
BATTERY CONNECTION
+24VOLTS
INDUCTION COIL
S
P
TREMBLING BELL
FUSE
NON-INDUCTIVE RESISTANCE
POWER GENERATORS
A.C.
D.C.
HEAT COIL
IMPEDANCE COIL
HAND GENERATOR
GALVANOMETER
RELAY
PRESS KEYS
AMMETER
AM
BULL'S-EYE INDICATOR. (GRAVITY RESTORED)
PLUGS
T
R
T
R
S
VOLTMETER
VM
DROP INDICATOR. (ELECTRICALLY RESTORED)
LINE
RELAY
HOWLER OR BUZZER CALL
RHEOSTAT
REPEATING COILS OR TRANSLATORS
1
2
3
LAMP
CONDENSERS
or
KEYS
LOCKING
NON LOCKING
1.
2.
PLUG-SEAT SWITCH

Diagram 103.

TYPES OF UNION KEYS.

THE NUMBERS SHOW THE CORRESPONDING SPRINGS IN THE TWO CASES.

ACTUAL — DIAGRAMMATIC — ACTUAL — DIAGRAMMATIC

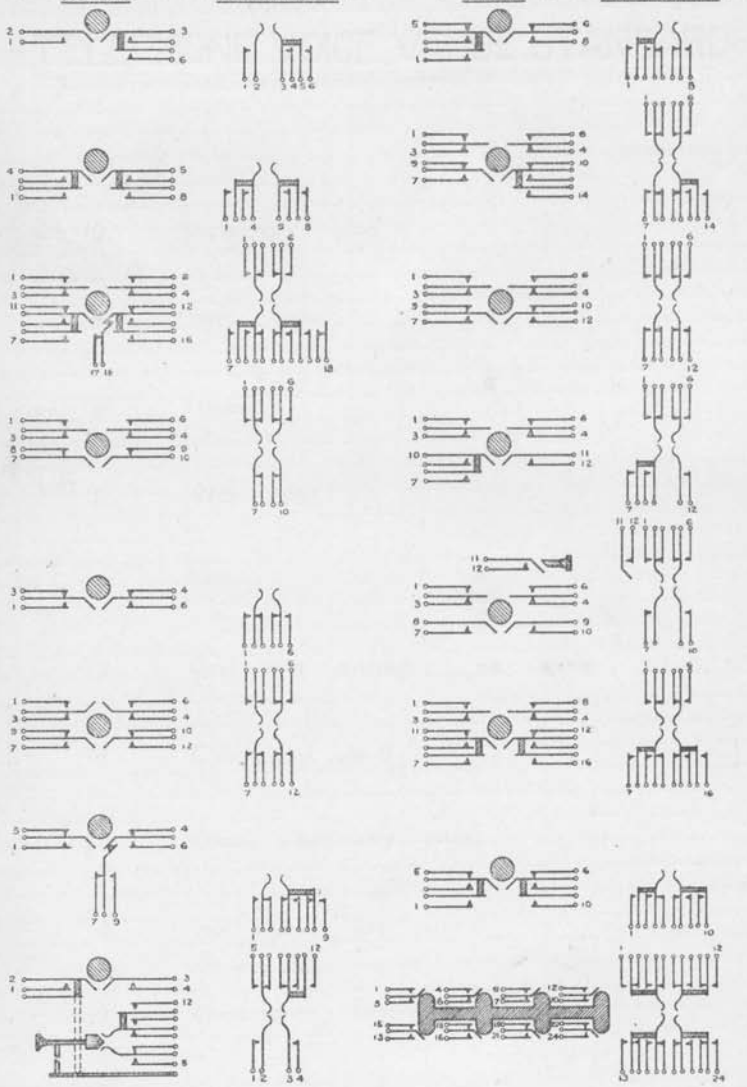


Diagram 104.

—TELEPHONE VOICE VALUE STANDARD—

10	Exceedingly good
9	Very good
8	Good
7	Very fair
6	Fair
5	Clear and distinct; no volume
4	Clear, but faint
3	Clear, but very faint
2	Not clear, very faint
1	Conversation impossible

Diagram 105.

Part V.

TESTING APPARATUS AND ELECTRICAL MEASUREMENTS.

STANDARD TRANSMISSION CIRCUIT.

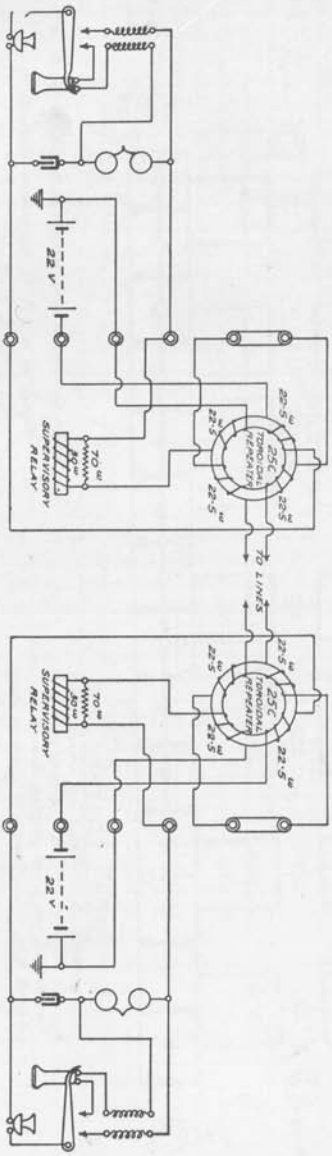
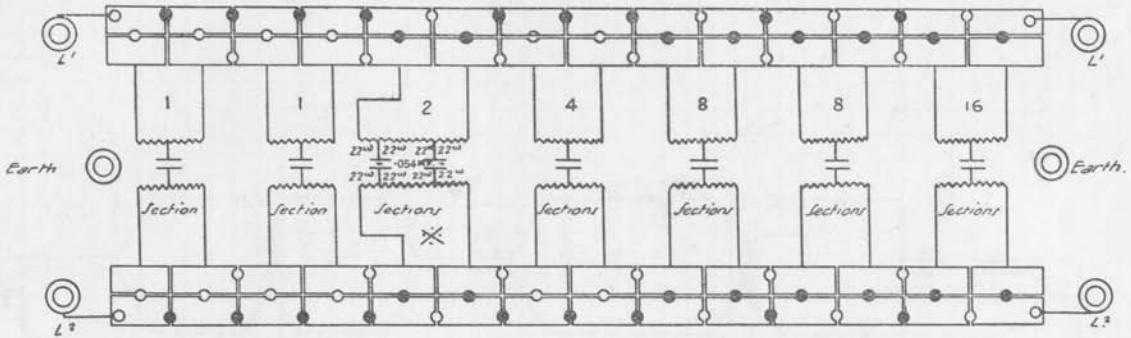


Diagram 106.



* Shews how 34 Sections are joined to plugs
A Section marked 1 = 1 mile of cable
" " 2 = 2 miles " " etc.

EXPLANATORY NOTE.

4 Sections will contain 4 condensers and 16 coils of 22ᵂ

The end portion on right (16 Sections) will contain 16. Condensers and 64 coils of 22ᵂ

Total 40 Sections containing 40 condensers and 160 coils of 22ᵂ representing 40 miles of Standard Cable.

ARTIFICIAL LINE. for TRANSMISSION TESTS ON C.B. TELEPHONES Prior to installation.

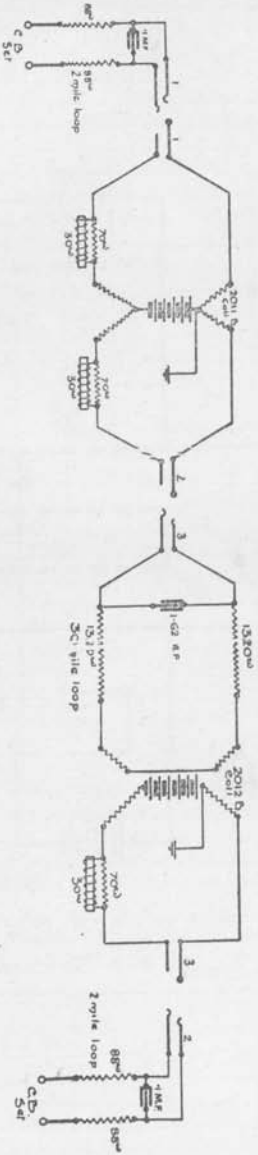
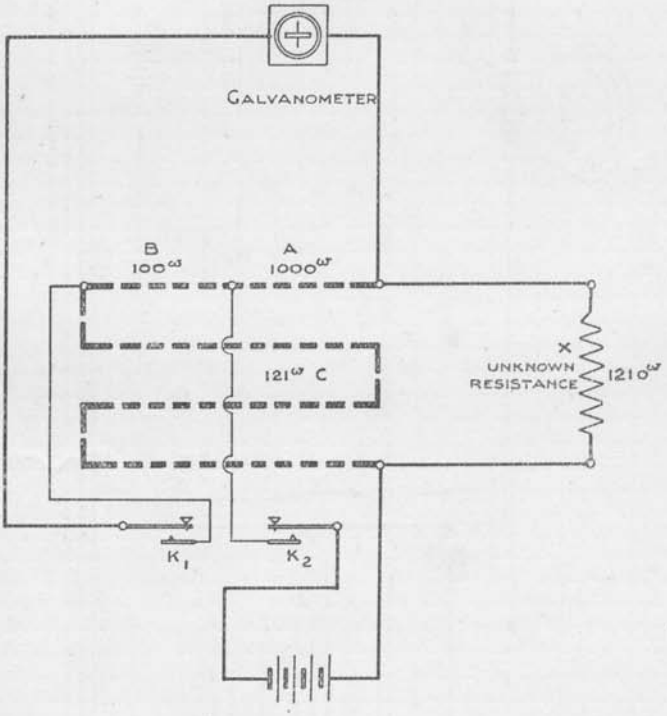


Diagram 108.

MEASUREMENT OF CONDUCTOR RESISTANCE.
by means of WHEATSTONE BRIDGE (P.O. Box.)



Adjust C until no deflection is obtained on Galvanometer upon depression of K_1 (K_2 being closed) Then $X = \frac{A \times C}{B}$ or where ratio arms A & B are equal $X = C$

Example A = 1000 B = 100 C = 121. Then $X = \frac{1000 \times 121}{100} = 1219^{\omega}$

Diagram 109.

MEASUREMENT OF RESISTANCE by means of MILLIAMPERE METER TESTING SET.

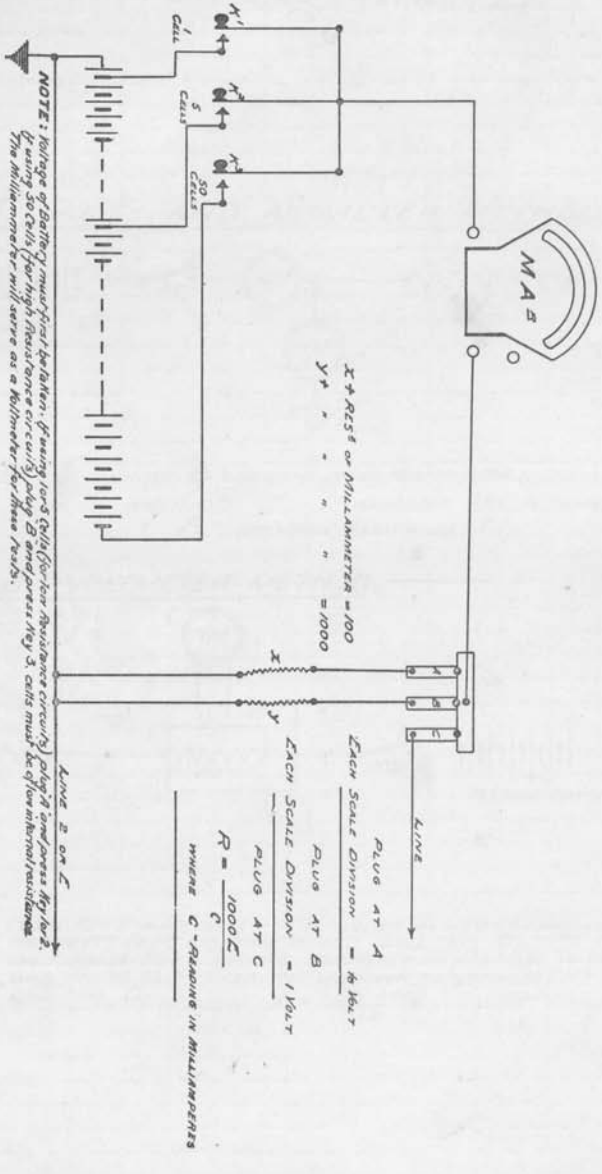
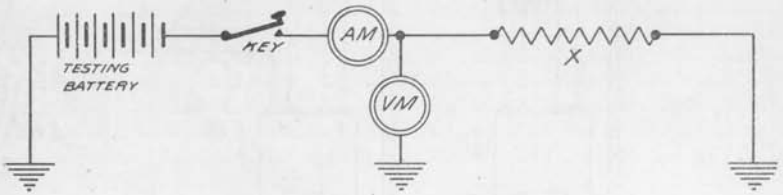


Diagram 110.

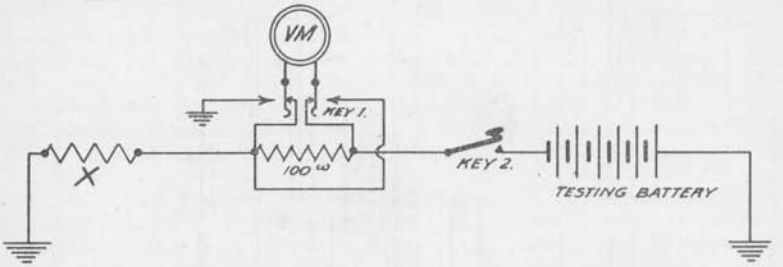
MEASUREMENT OF RESISTANCE BY MEANS OF VOLTMETER AND AMMETER.

1. VOLT-, AND AMMETER METHOD



$R = \frac{E}{C}$ WHERE E = READING OF VOLTMETER VM IN VOLTS
AND C = " " AMMETER AM IN AMPERES
" R = UNKNOWN RESISTANCE (X)

2. VOLTMETER METHOD



CLOSE KEY 2 AND OBSERVE DEFLECTION WITH KEY 1 NORMAL. THIS GIVES D.P. OVER 100 OHMS. CALL THIS D_1. THEN PRESS KEY 1 PUTTING VOLTMETER IN PARALLEL WITH, AND GIVING D.P. OVER THE UNKNOWN RESISTANCE (X) CALL THIS D_2, THEN $X = \frac{D_2 \times 100}{D_1}$

Diagram 111.

MEASUREMENT of RESISTANCE by means of BRIDGE MEGGER.

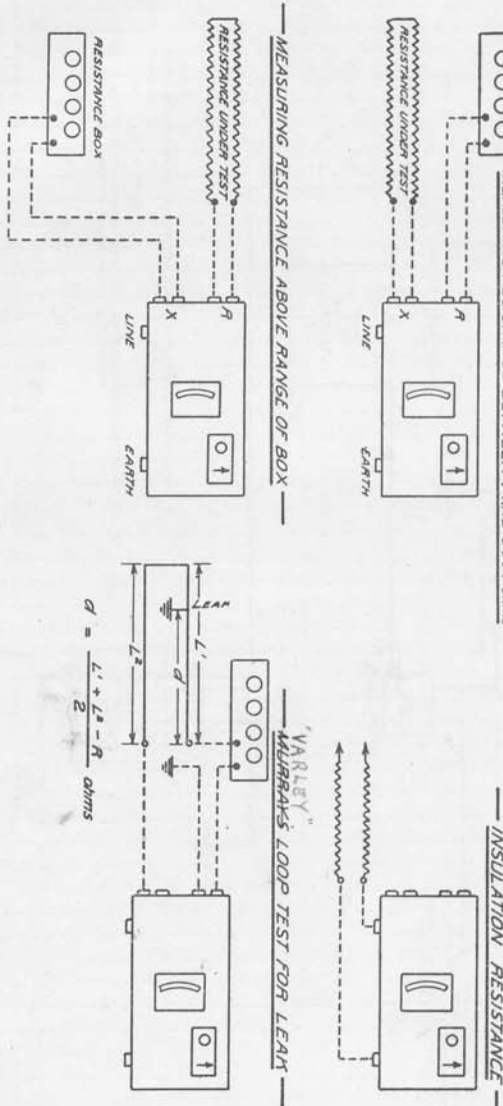


Diagram 112.

MEASUREMENT OF INSULATION RESISTANCE by means of Reflecting galvanometer.

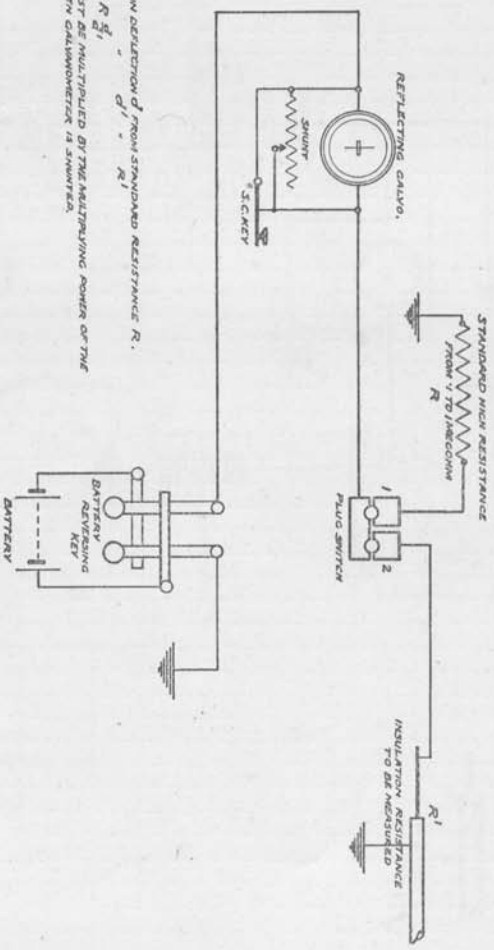


Diagram 113.

MEASUREMENT OF CAPACITY by the DIRECT DEFLECTION METHOD.

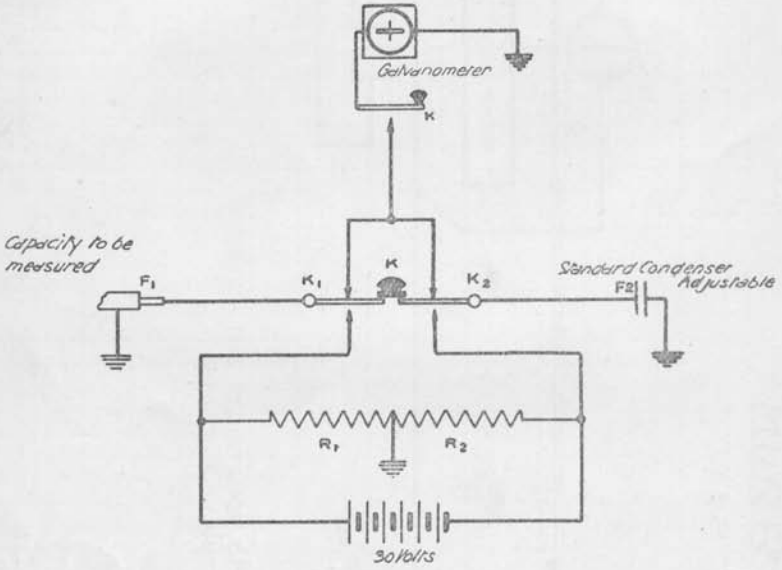
Diagram 114.

NOTE.— During any one test the Shunt must not be altered whilst obtaining deflections from F & F'.

Capacity of $F' = \frac{Fd'}{d}$

where d is discharge deflection from F. and d' . . . . F'.

MEASUREMENT OF CAPACITY by THOMSON'S METHOD.

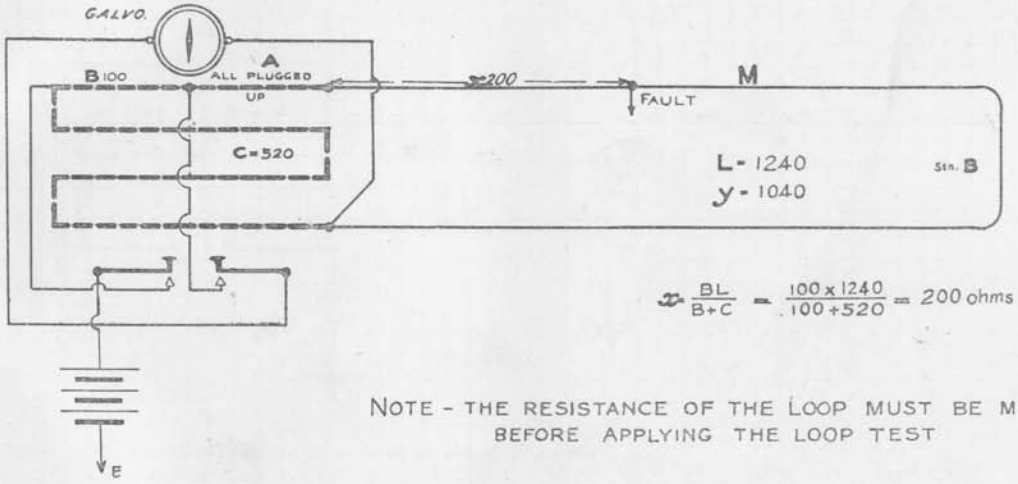


Ajust R_1 and R_2 as nearly as can be estimated in the proportion F_2 to F_1 Depress K_1 and K_2 by knob K Release K and allow charges to mingle then close K Adjust R_1 and R_2 until no deflection on pressing K then Capacity of $F_1 = \frac{R_2 F_2}{R_1}$

Diagram 115.

MURRAY'S, TEST

LOOP TEST.



$$x = \frac{BL}{B+C} = \frac{100 \times 1240}{100+520} = 200 \text{ ohms}$$

NOTE - THE RESISTANCE OF THE LOOP MUST BE MEASURED BEFORE APPLYING THE LOOP TEST

Diagram 116.

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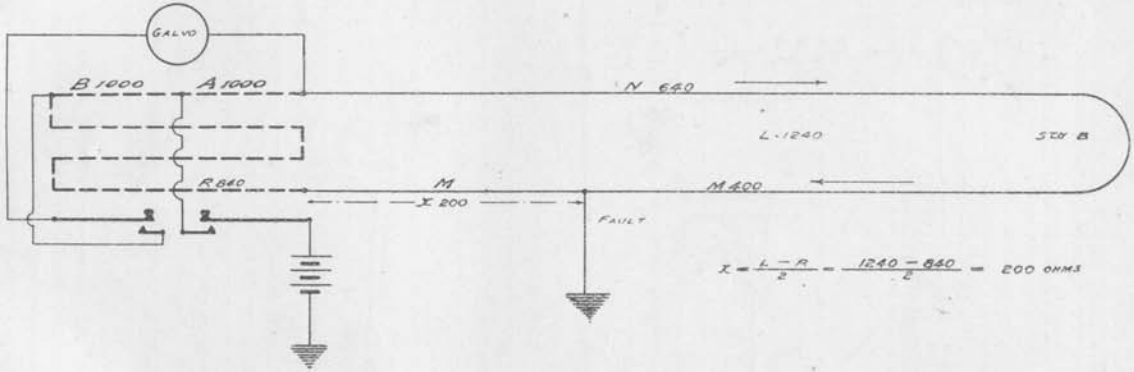
C.6133.—Z

VARLEY'S, TEST.

LOOP TEST.

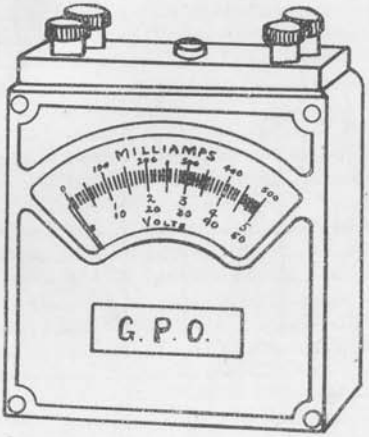


NOTE – THE RESISTANCE OF THE LOOP MUST BE MEASURED BEFORE APPLYING THE LOOP TEST

Diagram 117.

C.6133.—72

LINEMANS DETECTOR B.P.O Type.



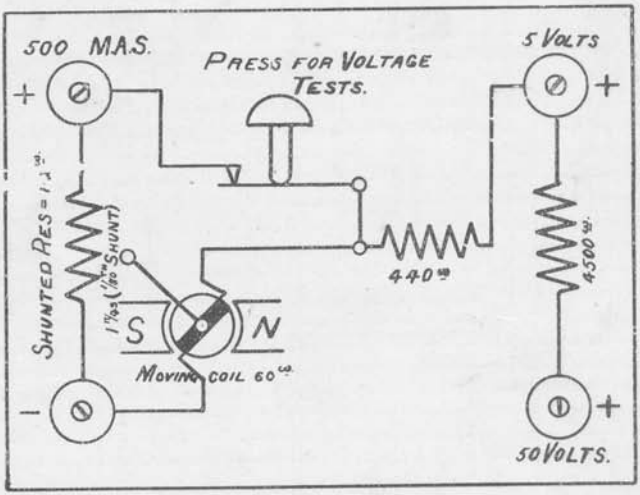


DIAGRAM OF CONNECTIONS.

Diagram 118.

INSULATION TEST of TRANSLATOR by means of Commonwealth MAGNETO Telephone.

E.C. 35

— FIG. 1. —

— FIG. 2. —

— Testing a Translator for Insulation —

Diagram 119.

TESTING SET, MAGNETO EXCHANGE, ERICSSON.

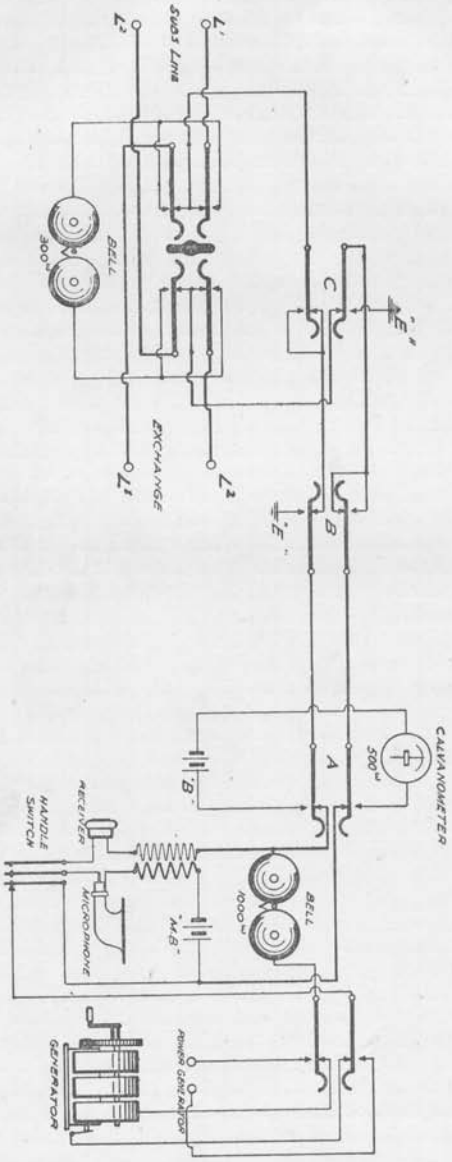


Diagram 120

APPENDIX.

APPENDIX

I.—Voltage and Internal Resistance of Various Types of Primary Cells in use in the Commonwealth.

Type of Cell.	Voltage.	Internal Resistance.
Leclanche, 3-pint	1·3 Volts ..	·8 ohm
,, 2-pint	1·3 ,, ..	1·0 ,,
Dry Cell, 3″ x 3″ x 7¼″	1·3 ,, ..	0·15 ,,
Meidinger Line	1 Volt ..	3 to 6 ohms
,, Local (Large)	1 ,, ..	2 ,, 4 ,,
Gravity, Callaud (9½″ x 5″) ..	1 ,, ..	1½ ,, 2½ ,,
,, Star Zinc (8¾″ x 6¾″) ..	1 ,, ..	1 ,, 2 ,,
Standard Cell, 3-pint	1 ,, ..	2 ohms (maximum)
,, ,, 2 pint	1 ,, ..	2 ,, ,,
,, ,, 1 pint	1 ,, ..	3 ,, ,,

NOTE.—The above figures are approximate, and represent the Voltage and Internal Resistance of the respective types of Cells in good working order under average conditions.

Method of Testing Cells by means of Lineman's Detector and Subdivided 5000 ohm. Resistance Box.

1. Take the Voltage reading on the lower or red scale of the Detector. Call reading V.1.

2. Shunt the Battery by means of the Testing Coil with a resistance of 2 ohms per Cell. Note immediately the second reading V.2 (It is important that this reading be taken immediately.)

3. At the end of one minute's application of the Shunt disconnect it. Note immediately the third reading V.3. (This reading also must be taken immediately after disconnexion.)

If V.2 be not less than half V.1 then the reading V.3 may be taken as the Effective Voltage of the Battery.

The internal resistance of the Battery may be then easily calculated. It will be equal to the product of the Shunt value (that is, 2 ohms) into the difference between V.1 and V.2, divided by V.2. *i.e.*—

$$R = \frac{S\ (V.1 - V.2)}{V.2.}$$

Where S is the resistance used to Shunt the Battery.

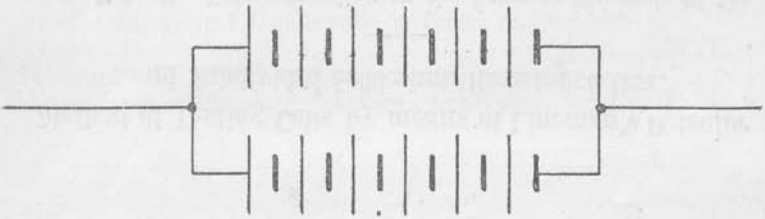
II.—Cells Connected in Series and in Parallel—Series.

CELLS IN SERIES.

Total E.M.F. .. .. = Number of Cells × E.M.F. of one Cell.

Total Internal Resistance = Number of Cells × Internal Resistance of one Cell.

CELLS IN PARALLEL.



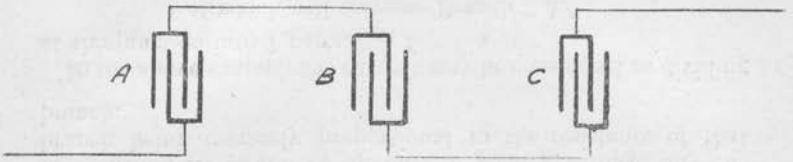
Total E.M.F. .. .. = Number of Cells in series (in one bank) × E.M.F. of one Cell.

Total Internal Resistance = Number of Cells in series × Internal Resistance of one Cell, divided by the number of banks of Cells.

NOTE.—When joining banks of Cells in parallel, care should be taken that the same number of similar Cells is connected in each bank.

III.—Condensers Connected in Series and in Parallel.

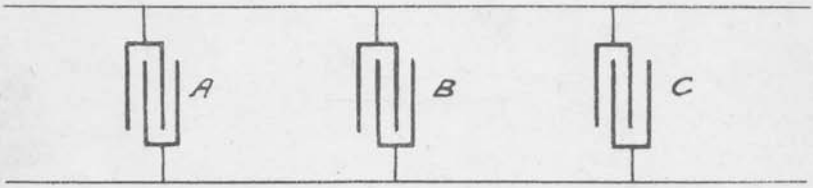
SERIES (OR CASCADE).



The total capacity obtained by joining Condensers in series is less than the capacity of any one of the Condensers so connected. Thus, three Condensers, A, B, and C, of 1, 2, an l 2 microfarads capacity respectively give a total capacity of $\frac{1}{2}$ microfarad when connected in series. The method of calculating the effective capacity (F) of Condensers in series is as follows :—

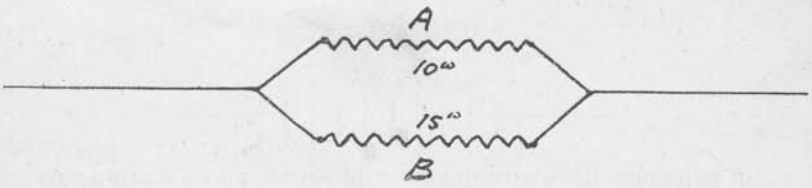
$$F = \frac{1}{\frac{1}{A} + \frac{1}{B} + \frac{1}{C}} = \frac{1}{\frac{1}{1} + \frac{1}{2} + \frac{1}{2}} = \frac{1}{\frac{4}{2}} = \frac{2}{4} = \frac{1}{2} \text{ mfd.}$$

PARALLEL.

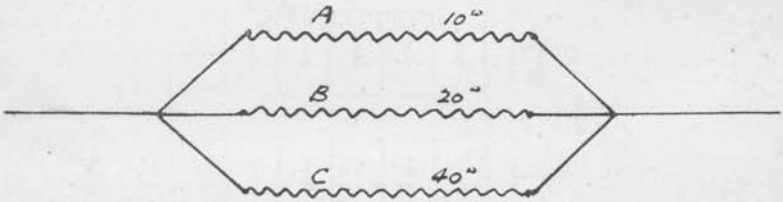


The total capacity obtained by joining Condensers in parallel s equal to the *sum* of the capacities of the Condensers so joined. Thus, three Condensers of 1, 2, and 2 microfarads capacity respectively give a total capacity of 5 microfarads when connected in parallel.

IV.—Joint Resistance of Conductors Connected in Parallel,



$$\text{Joint Resistance of A and B} = \frac{A \times B}{A + B} = \frac{10 \times 15}{25} = 6 \text{ ohms}$$



$$\text{Joint Resistance of A, B, and C} = \frac{1}{\frac{1}{10} + \frac{1}{20} + \frac{1}{40}} = \frac{1}{\frac{4}{40} + \frac{2}{40} + \frac{1}{40}} = \frac{1}{\frac{7}{40}} = \frac{40}{7} = 5{\cdot}7 \text{ ohms.}$$

A current flowing in the main circuit will divide at the junction of branches, A, B, and C, the current passing through any one branch being inversely proportional to the resistance of that branch.

In the above example the current may be considered as dividing at the junction into 7 parts,

4 of which will traverse Branch "A."
2 ,, ,, ,, ,, "B."
1 ,, ,, ,, ,, "C."

V.—OHM'S LAW.

$$\text{Current (in amperes)} = \frac{\text{E.M.F. (in Volts)}}{\text{Resistance (in ohms)}} \qquad C = \frac{E}{R}$$

$$\text{Resistance} \quad .. \quad = \frac{\text{E.M.F.}}{\text{Current}} \quad .. \quad .. \quad R = \frac{E}{C}$$

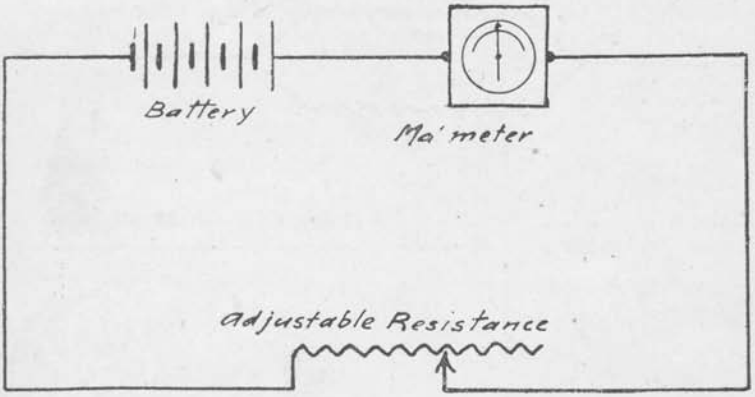
$$\text{E.M.F.} \quad .. \quad = \text{Current} \times \text{Resistance} \qquad E = CR$$

A Millivolt is the one-thousandth part of a Volt.

A Milliampere is the one-thousandth part of an Ampere.

$$\text{Current (in Milliamperes)} = \frac{\text{Volts} \times 1000}{\text{ohms}}$$

VI.—Measurement of Internal Resistance of Battery by the Half Deflection Method.



(1) Adjust Resistance to such a value (R) that a conveniently large deflection is obtained on the Milliamperemeter.

(2) Increase Resistance to R, so that the deflection on Milliamperemeter is exactly one-half of the first deflection. Then the Internal Resistance of Battery = R − (2R + M), where M is Resistance of the Milliamperemeter. If the Milliamperemeter is of comparatively low resistance, as is usually the case, its effect may be neglected in the calculation, and the Resistance of Battery is then found by subtracting twice the value of the first Resistance from the value of the second Resistance.

Example.—A Battery of 30 Meidinger Cells produced a current of 120 Milliamperes when R was made 100 ohms. To reduce the current to 60 Milliamperes it was found necessary to make R 350 ohms. The Resistance of the Milliamperemeter used was less than 1 ohm.

The Internal Resistance of Battery therefore = R − 2R = 350 − (2 × 100) = 150 ohms.

100 — 700

VII.—Resistance per mile (at 60° Fahrenheit) of Various Conductors in General Use.

Class of Conductor.	Resistance at 60° Fahrenheit.	
	Standard.	Maximum Allowable.
Copper, H.D.—		
600 lbs. per mile	1·4645 ohms per mile ..	1·4938 ohms per mile
400 „ „	2·1968 „ „ ..	2·2408 „ „
300 „ „	2·9291 „ „ ..	2·9877 „ „
200 „ „	4·3936 „ „ ..	4·4815 „ „
150 „ „	5·8582 „ „ ..	5·9754 „ „
100 „ „	8·7873 „ „ ..	8·9630 „ „
Tinned No. 16 LSWG, twisted pair outside distributing wire	.. .. ..	13·87 ohms per conductor per pair mile
Tinned No. 18 LSWG, twisted pair outisde distributing wire	.. .. ..	24·74 ohms per conductor per pair mile
Copper, Annealed Tinned—		
No. 18 LSWG ..	.. .. ..	24·0885 ohms per mile
„ 20 „ ..	.. .. ..	42·8240 „ „
„ 22 „ ..	.. .. ..	70·7909 „ „
„ 23 „ ..	.. .. ..	95·392 „ „
„ 24 „ ..	.. .. ..	114·635 „ „
Bronze—		
100 lb. per mile ..	.. .. ..	20·30 „ „
70 „ „ ..	.. .. ..	29·00 „ „
50 „ „ ..	.. .. ..	40·60 „ „
40 „ „ ..	.. .. ..	50·75 „ „
Galvanized Iron—		
600 lbs. per mile..	8·88 ohms per mile ..	The product of the Weight in pounds per mile into the Resistance in ohms per mile must not exceed 5328.
500 „ „ ..	10·66 „ „ ..	
450 „ „ ..	11·84 „ „ ..	
400 „ „ ..	13·32 „ „ ..	
300 „ „ ..	17·76 „ „ ..	
200 „ „ ..	26·64 „ „ ..	
150 „ „ ..	35·52 „ „ ..	
100 „ „ ..	53·28 „ „ ..	
75 „ „ ..	71·04 „ „ ..	

The Ohm-mile Constant for wire of any material is obtained by multiplying the Resistance (in ohms) of a mile of wire of the material by its Weight in pounds.

The Ohm-mile Constant, divided by the Weight in pounds of a mile of wire of any size will give its Resistance, and divided by its Resistance will give its Weight in pounds.

The Ohm-mile Constant for H.D. High Conductivity Commercial Copper Wire is :—Standard, 878·8 ; Maximum allowable, 896·4. The Ohm-mile Constant (maximum allowable) for Iron Wire is 5328.

VIII.—The Table given below shows the Sizes of Various Wires of Different Materials which will Fuse at the Currents given in the First Column.

(Sir W. H. Preece.)

Current in Amperes.	Tin Wire.		Lead Wire.		Copper Wire.		Iron Wire.	
	Diameter, Inches.	Approximate. S.W.G.	Diameter, Inches.	Approximate. S.W.G.	Diameter, Inches.	Approximate. S.W.G.	Diameter, Inches.	Approximate. S.W.G.
1	0·0072	36	0·0081	35	0·0021	47	0·0047	40
2	0·0113	31	0·0128	30	0·0034	43	0·0074	36
3	0·0149	28	0·0168	27	0·0044	41	0·0097	33
4	0·0181	26	0·0203	25	0·0053	39	0·0117	31
5	0·0210	25	0·0236	23	0·0062	38	0·0136	29
10	0·0334	21	0·0375	20	0·0098	33	0·0216	24
15	0·0437	19	0·0491	18	0·0129	30	0·0283	22
20	0·0529	17	0·0595	17	0·0156	28	0·0343	20·5
25	0·0614	16	0·0690	15	0·0181	26	0·0398	19
30	0·0694	15	0·0779	14	0·0205	25	0·0450	18·5

Note.—The above numbers can only be taken as approximate, as the actual current required to fuse any gauge will depend on the length of fuse and cooling effects of the fuse block in which it is placed.

IX.—Co-efficients for Converting Observed Copper Resistances.

(Resistance at 60° F. = Observed Resistance × Co-efficient.)

Temperature, Fahrenheit.	Co-efficient.	Temperature, Fahrenheit.	Co-efficient.	Temperature, Fahrenheit.	Co-efficient.
85	·94677	67	·98454	49	1·02523
84	·94901	66	·98672	48	1·02758
83	·95083	65	·98891	47	1·02995
82	·95288	64	·99111	46	1·03232
81	·95493	63	·99331	45	1·03470
80	·95698	62	·99554	44	1·03710
79	·95906	61	·99776	43	1·03950
78	·96113	60	1·00000	42	1·04192
77	·96321	59	1·00224	41	1·04434
76	·96531	58	1·00450	40	1·04678
75	·96742	57	1·00677	39	1·04922
74	·96953	56	1·00904	38	1·05168
73	·97164	55	1·01132	37	1·05415
72	·97377	54	1·01361	36	1·05662
71	·97590	53	1·01592	35	1·05912
70	·97805	52	1·01823	34	1·06162
69	·98021	51	1·02055	33	1·06414
68	·98237	50	1·02289	32	1·06666

The average temperature Co-efficient for Copper Conductors = ·00238 per degree Fahrenheit (·00428 per degree Centigrade).

X.—British Standard Sizes of Annealed High Conductivity Commercial Copper Conductors.

NUMBERS OF WIRES IN SMALL FLEXIBLE CONDUCTORS.

Equivalent Solid Wire S.W.G.	No. 40 S.W.G.	No. 38 S.W.G.	No. 36 S.W.G.	No .33 S.W.G.	No. 30 S.W.G.
23	25	16	10	..	..
22	34	22	14	..	..
21	44	29	18	10	..
20	56	36	23	13	..
19	70	45	28	16	10
18	100	64	40	23	15
17	136	87	54	31	21
16	178	114	70	41	27
15	225	144	90	52	34
14	278	178	110	64	42

XI.—British Standard Wire Gauge.

S.W.G.	Diameter in Mils. 1 Mil = 0·001 in.	Pure Copper Wire, 60° F.		
		Resistance in Ohms.		Weight in lbs. per Mile.
		Per Yard	Per Mile.	
4	232	·00057	1·00	860
5	212	·00068	1·20	718
6	192	·00083	1·46	589
7	176	·00099	1·74	495
8	160	·00119	2·10	409
9	144	·00148	2·60	331
10	128	·00187	3·29	262
11	116	·00228	4·00	215
12	104	·00283	4·98	173
13	92	·00362	6·37	135·3
14	80	·00478	8·42	102·3
15	72	·00590	10·39	82·9
16	64	·00748	13·16	65·5
17	56	·00976	17·18	50·1
18	48	·01328	23·38	36·8
19	40	·0191	33·67	25·6
20	36	·0236	41·6	20·72
21	32	·0300	52·6	16·37
22	28	·0390	68·7	12·53
23	24	·0532	93·5	9·21
24	22	·0638	111·3	7·73
25	20	·0765	134·7	6·39
26	18	·0945	166·3	5·18
27	16·4	·1140	200·4	4·30
28	14·8	·1400	246	3·50
29	13·6	·1655	291·3	2·96
30	12·4	·200	350·3	2·46
31	11·6	·227	400·4	2·15
32	10·8	·262	462	1·86
33	10	·306	538·8	1·60
34	9·2	·361	636·6	1·353
35	8·4	·434	763·6	1·128
36	7·6	·530	933	·923
37	6·8	·662	1165	·739
38	6	·850	1497	·575
39	5·2	1·132	1992	·432
40	4·8	1·328	2338	·368
41	4·4	1·581	2782	·309
42	4	1·913	3367	·256
43	3·6	2·362	4157	·2072
44	3·2	2·990	5262	·1637
45	2·8	3·905	6872	·1253
46	2·4	5·316	9355	·0921
47	2	7·654	13470	·063[illegible]
48	1·6	11·95	21040	·0409
49	1·2	21·26	37420	·0230
50	1	30·61	53880	·0160

One per cent. increased resistance as calculated from the diameter is allowed on all Tinned Copper Conductors between the diameters of 0·118 inch and 0·028 inch inclusive.

Hard drawing increases the resistance of Copper Conductors by approximately 2·05 per cent.

XII.—Useful Numbers.

$$\pi = \frac{\text{Circumference}}{\text{Diameter}} \text{ of Circle} = 3{\cdot}1416 = \frac{22}{7} \text{ nearly.}$$

Circumference (C) of Circle = Diameter $\times \pi$ = Radius (r) $\times 2\pi$.

$$\text{Diameter (D) of Circle} = \frac{\text{Circumference}}{\pi} = C \times \frac{1}{\pi} = C \times {\cdot}3183.$$

$$\text{Area of Circle} = D^2 \times \frac{\pi}{4} = D^2 \times {\cdot}7854 = r^2 \times \pi.$$

Area of Circle in Circular Mils = $D^2 = 4r^2$ (D and r in Mils).

Weight in lbs. of Water = ·036 per cubic inch; 62·4 per cubic foot; 10 per gallon.

Weight in lbs. of 1 cubic inch—Of Aluminium, = ·096; Copper, = ·318; Cast Iron, = ·26; Wrought Iron, = ·28; Steel, = ·288; Lead, = ·41; Mercury, = ·49; Tin, = ·26; Zinc, = ·25; Brass, = ·3; Bronze, = ·316.

One horse-power = 33,000 foot lbs. per minute = 746 watts.

One nautical mile, or naut, = 6086 ft. (nearly).

One telegraph naut = 6087 feet.

A knot is a velocity of one nautical mile per hour.

XIII.—To Convert—

Mils to Millimetres, × ·0254.	Millimetres to Mils, × 39·37.
Inches to Centimetres, × 2·54.	Centimetres to Inches, × ·3937
Feet to Metres, × ·3048.	Metres to Feet, × 3·281
Square Inches to Square Cms., × 6·452.	Square Cms. to Square Inches, × ·155.
Cubic Inches to Cubic Cms., × 16·387.	Cubic Cms. to Cubic Inches, × ·061.
Ounces to Grammes, × 28·35.	Grammes to Ounces, × ·0353.
Pounds (7,000 grains) to Kilogrammes, × ·4536.	Kilogrammes to Pounds, × 2·205.
Ohms per Yard to Ohms per Metre, × 1·0936.	Ohms per Metre to Ohms per Yard, × ·9144.
Ohms per Mile to Ohms per Kilometre, × ·6214.	Ohms per Kilometre to Ohms per mile, × 1·609.
Degrees Fahrenheit to Centigrade, deduct 32, × 5, and ÷ 9.	Degrees Centigrade to Fahrenheit, × 9 ÷ 5, and add 32.
Nauts to Statute Miles, × 1·1527.	Statute Miles to Nauts, × ·8675.
Nauts (Telegraph) to Statute Miles, × 1·1528.	Statute Miles to Nauts (Telegraph). × ·8674.

XIV.—Colour Code for Switchboard Cables.

Column 1.	Column 2.	Column 3.	Column 4.	Column 5.
White ..	Blue.. ..	Red Blue ..	Red ..	Black Blue
,, ..	Orange ..	Red Orange ..	,, ..	Black Orange
,, ..	Green ..	Red Green ..	,, ..	Black Green
,, ..	Brown ..	Red Brown ..	,, ..	Black Brown
,, ..	Slate ..	Red Slate ..	,, ..	Black Slate
,, ..	Blue White ..	Red Blue White ..	,, ..	Black Blue White
,, ..	Blue Orange ..	Red Blue Orange ..	,, ..	Black Blue Orange
,, ..	Blue Green ..	Red Blue Green ..	,, ..	Black Blue Green
,, ..	Blue Brown ..	Red Blue Brown ..	,, ..	Black Blue Brown
,, ..	Blue Slate ..	Red Blue Slate ..	,, ..	Black Blue Slate
,, ..	Orange White	Red Orange White	,, ..	Black Orange White
,, ..	Orange Green	Red Orange Green	,, ..	Black Orange Green
,, ..	Orange Brown	Red Orange Brown	,, ..	Black Orange Brown
,, ..	Orange Slate ..	Red Orange Slate	,, ..	Black Orange Slate
,, ..	Green White ..	Red Green White	,, ..	Black Green White
,, ..	Green Brown	Red Green Brown..	,, ..	Black Green Brown
,, ..	Green Slate ..	Red Green Slate ..	,, ..	Black Green Slate
,, ..	Brown White	Red Brown White	,, ..	Black Brown White
,, ..	Brown Slate ..	Red Brown Slate ..	,, ..	Black Brown Slate
,, ..	Slate White ..	Red Slate White ..	,, ..	Black Slate White
Spare Wires :				
White ..	Black ..	Red White ..	Red ..	Black Red White

Columns 1 and 2 make 43 Wire Cable, 3 spare wires.
Columns 1, 2, and 3 make 64 Wire Cable, 44 spare wires
Columns 1, 2, 3, and 4 make 84 Wire Cable, 4 spare wires.
Columns 1, 2, 3, 4, and 5 make 105 Wire Cable, 5 spare wires.

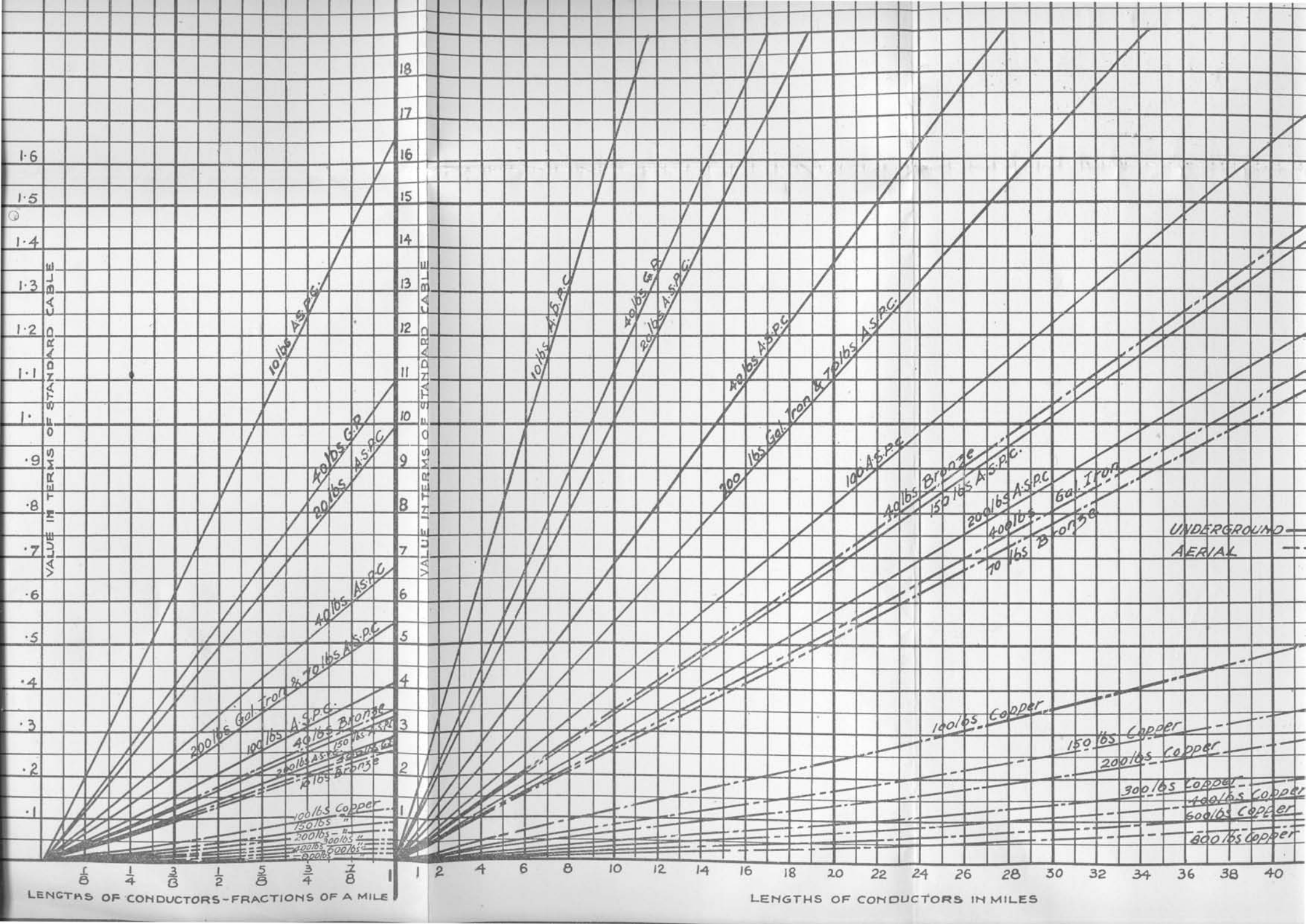
XV.—Table of Equivalent Lengths of Line and Limiting Distances for Commercial Speech.

Type of Line.	Constants per Mile of Loop.			Equivalent Lengths in Miles calculated.	Limiting Distances for Commercial Speech.	
	R Ohms.	K M.F.'s.	L Henries.		Calculated.	Experiment.
				Miles.	Miles.	Miles.
Underground—						
10-lb. cable ..	175·64	·07	·001	0·61	26	26
20-lb. „ ..	86	·055	·001	1	43	43
40-lb. „ ..	42	·056	·001	1·47	63	63
70-lb. „ ..	25	·063	·001	1·83	79	
1 0-lb. „ ..	17	·058	·001	2·45	105	
150-lb. „ ..	11·7	·065	·001	2·95	127	127
200-lb. „ ..	8·75	·07	·001	3·5	151	
Submarine—						
160-lb. cable..	12·9	·12	·00165	2·3	99	88
Aerial lines—						
100-lb. copper	18	·00808	·0039	8·45	363	
150-lb. „	11·9	·00839	·00376	11·7	503	473
200-lb. „	9	·00862	·00366	14·7	632	626
300-lb. „	6	·00893	·00355	21	903	903
400-lb. „	4·5	·00919	·00344	26·1	1,122	1,075
600-lb. „	2·97	·00958	·00331	36·8	1,582	1,582
800-lb. „	2·25	·00987	·00322	45·8	1,969	

The above table is taken from the Presidential Address of Mr. J. Gavey to the Institution of Electrical Engineers on 9th November, 1905. Columns 5 and 6 have been calculated from the formulæ of Professor Pupin for attenuation in the case of the cable lines where leakage can be neglected, and from that of Professor Campbell in the case of aerial lines—the latter formula taking into account the insulation, at the rate of 1 megohm per mile.

The unit in this table is 1 mile of Standard Cable (20 lbs. per mile) having the constants per mile of loop shown above. Standard Cable is now defined, however, as cable having copper conductors weighing twenty (20) lbs. per mile (36 mils diameter) with a loop resistance of eighty-eight (88) ohms per mile, and a capacity wire to wire of 0·054 microfarad per mile. The inductance is 1 millihenry (0·001 Henry), and the insulation resistance two hundred (200) megohms per mile—all the constants being measured at sixty (60) degrees Fahrenheit.

The Table of Equivalents will be found of great value in the economical design of circuits to fulfil any required standards, the numbers given in column 5, or their reciprocals, being used as factors in connexion with any particular class of line.


VALUE IN TERMS OF STANDARD CABLE
1·6
1·5
1·4
1·3
1·2
1·1
1·
·9
·8
·7
·6
·5
·4
·3
·2
·1
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
10 lbs A.S.P.C.
40 lbs G.P.
20 lbs A.S.P.C.
40 lbs A.S.P.C.
200 lbs Gal. Iron & 70 lbs A.S.P.C.
100 lbs A.S.P.C.
40 lbs Bronze
150 lbs A.S.P.C.
200 lbs A.S.P.C.
400 lbs Gal. Iron
70 lbs Bronze
100 lbs Copper
150 lbs "
200 lbs "
300 lbs "
400 lbs "
600 lbs "
800 lbs "
1/8 1/4 3/8 1/2 5/8 3/4 7/8 1
LENGTHS OF CONDUCTORS - FRACTIONS OF A MILE
1 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
LENGTHS OF CONDUCTORS IN MILES
UNDERGROUND
AERIAL

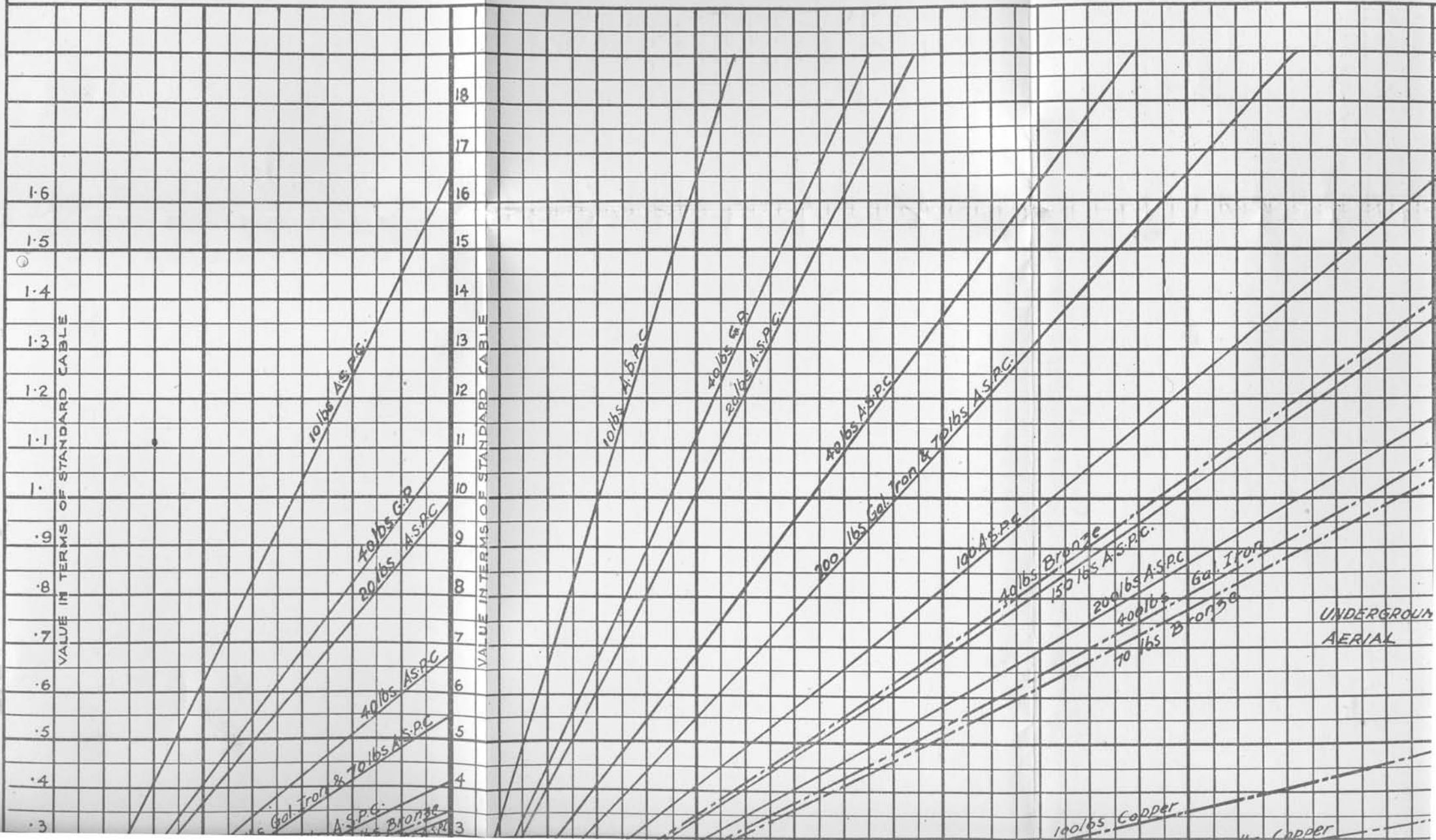
— COMMONWEALTH OF AUSTRALIA —

— POSTMASTER GENERAL'S DEPARTMENT —

— CURVES SHOWING FOR VARIOUS AERIAL AND UNDERGROUND CONDUCTORS THE VALUES IN TERM

STANDARD CABLE —

EXAMPLE :– 8 MILES OF 10LBS A·S·P·C = 13 MILES STANDARD CABLE.



XVII.—Table of the Effective Resistance, Inductance, and Impedance of Standard Telephone Apparatus at 1,000 Alternations per Second.

Apparatus.	Effective Resistance.	Inductance.	Impedance.		Loss in Milliwatts per 1 Volt.
	Ohms.	Henries.	Ohms.	Angle.	
BELLS—					
1,000-ohm magneto ..	7,580	1·305	11,140	47° 9′	·061
INDICATORS—					
1,000-ohm tubular, ordinary..	8,000	1·2	11,000	43° 24′	·066
600-ohm self-restoring ..	8,055	1·3	11,410	44° 55′	·062
100-ohm, plus 100-ohm eyeball signal, unoperated ..	3,900	0·512	4,035	14° 45′	·240
100-ohm, plus 100-ohm eyeball signal, operated	4,300	0·539	4,440	14° 3′	·219
RECEIVERS—					
Double-pole bell (60-ohm central battery)	134	0·018	176	40° 34′	4·33
RELAYS—					
500-ohm double make-and-break (W.E.) armature, not attracted	7,160	1·157	10,210	44° 54′	·069
500-ohm double make-and-break (W.E.) armature, attracted	7,960	1·238	11,150	44° 24′	·064
1,000-ohm double make-and-break (W.E.) armature, not attracted	9,910	1·543	13,845	44° 18′	·052
1,000-ohm double make-and-break (W.E.) armature, attracted	9,970	1·617	14,230	45° 30′	·049
RETARDATION COILS—					
100-ohm tubular	1,116	0·191	1,640	47° 6′	·414
200-ohm tubular	3,170	0·550	4,690	47° 30′	·144
400-ohm tubular	4,700	0·664	6,280	41° 30′	·119
600-ohm tubular	5,906	0·890	8,132	43° 20′	·089
1,000-ohm tubular, differential	19,100	0·538	19,400	10° 0′	·051
75-ohm, plus 75-ohm W.E. pattern, No. 202OA ..	1,827	1·367	8,770	77° 58′	·024
200-ohm, plus 200-ohm W.E. toroidal, No. 44B ..	3,600	13·5	85,000	87° 34′	·0005
NO. 1 CENTRAL BATTERY TERMINATION (consisting of repeater, supervisory relay, local line and subscriber's instrument)—					
(*a*) No. 25 repeater, local line, 0-ohm	330	0·049	451	42° 57′	1·62
(*b*) No. 25 repeater, local line, 300-ohm (ohmic) ..	630	0·068	760	33° 54′	1·09
(*c*) No. 25 repeater, local line, 3-m. 20-lb. cable ..	680	0·049	746	23° 51′	1·22

NOTE.—To obtain loss in milliwatts at any voltage V, multiply figures in last column by V^2.

The values of Effective Resistance, Inductance, and Impedance given above cannot be taken as accurate in the case of apparatus having the same ohmic resistance as similar apparatus in column 1, but differing from the latter in physical dimensions.

The preceding table is abstracted from an article on "The Impedance of Telephonic Apparatus," by B. S. Cohen, published in *The National Telephone Journal* for September, 1909, to which article and one on "Notes on an Instrument for Measuring Inductance," by G. M. B. Shepherd, given in the April, 1909, number of the same journal, the reader is referred for full particulars of the methods of measurement by means of alternating currents of high frequency (1,000 per second), so as to obtain a very close approximation to the effective resistance and impedance which the various classes of apparatus offer to the rapid alternations of actual speech-transmitting currents.

The measurements have been made at a frequency of 1,000 alternations, which, with a current strength of from 0·3 to 2 milliamperes, has been found to give an equivalent effect to actual speech waves.

It will be seen that the effective resistances and impedances given in the second and fourth columns differ very materially from the ordinary ohmic resistances to continuous current given in the first column, and this explains why a comparatively low ohmic resistance shunt, such as a 100-ohm retardation coil, has no appreciable effect on the speaking transmission when joined across even a long line, since the impedance of such a shunt to speech currents is raised more than sixteenfold.

Albert J. Mullett,
Government Printer, Melbourne.