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PW—F. 3.

Post Office Engineering Department

TECHNICAL PAMPHLETS FOR WORKMEN

Subject:

Subscribers' Apparatus. Magneto.

ENGINEER-IN-CHIEF'S OFFICE
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LIST OF Technical Pamphlets for Workmen

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17. Internal Cabling and Wiring.
18. Distribution Cases, M.D.F. and I.D.F

[Continued on page iii of Cover.]

SUBSCRIBERS' APPARATUS. MAGNETO.

(F.3.)

*The following pamphlets in this series are of
kindred interest.*

- A.2. Primary Batteries.
- D.1. Elementary Principles of Telephony.
- D.4. Magneto Exchanges—Non-Multiple Type.
- D.5. Magneto Exchanges—Multiple Type.
- D.15. Telephone Testing Equipment.
- D.19. Cord Repairs.
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SUBSCRIBERS' APPARATUS.—MAGNETO.

DESCRIPTION OF APPARATUS.

There are six principal pieces of apparatus used in connection with the set supplied at the subscriber's end of a magneto telephone circuit. These are as follows:—

1. Receiver.
2. Transmitter.
3. Battery.
4. Induction Coil.
5. Generator.
6. Bell.

The first four form that part of the set used in carrying on speech between the subscriber, the exchange operator and other subscribers. The last two provide for signalling by the subscriber to the exchange or by the exchange to the subscriber.

1. The function of the Receiver, as its name implies, is to receive the speech from the distant end of the line. This is done by the currents sent along the line passing through the coils

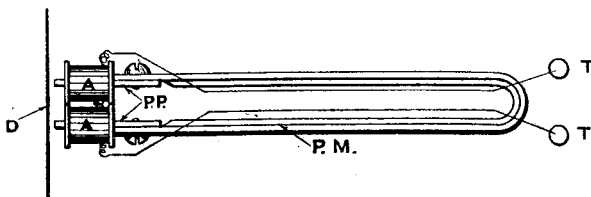


Fig. 1.

on the receiver and causing the diaphragm to vibrate in harmony with these varying currents. Fig. 1 shows the essential parts of the receiver with the enclosing case removed, so as to show the coils *AA*, pole pieces *PP* fixed on the ends of the permanent horseshoe magnet *PM*, the pole pieces forming the cores of soft iron in the centre of the coils, the diaphragm *D* and terminals *TT*, to which the ends of the wire wound on the coils are brought, and to which also the ends of the flexible cord, connecting the receiver to the set, are attached.

Although the details and form of the parts may vary from that shown, as in the Watch receiver or in that used with the hand micro-telephone, these parts are used in all types.

The general construction of the watch receiver and also that

used on the hand micro-telephone is shown in Fig. 2, from which it will be seen that the main difference lies in the fact that the permanent magnet *PM* is circular in form instead of the horseshoe type, the pole pieces *PP*, carrying the coils *AA*, being connected on opposite sides of the ring.

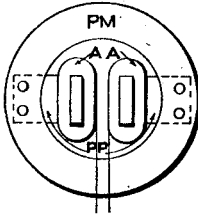


Fig. 2.

The connections from the coils are brought out in some cases to the back, and in others to the side, of the receiver.

The diaphragm is of iron and is held in place by the cap of the receiver, which is screwed on to the case. The pole pieces should be exactly in line with the edge of the case when the cap is removed, and in order that the diaphragm may be kept at the proper distance from the pole pieces a thin and narrow ring, either of paper or metal, is placed between the diaphragm and the case on which it rests. In this way ready means of adjustment are provided.

2. The Transmitter (Fig. 3) consists of the following essential parts: a containing case *B*; a diaphragm *D*; a carbon block *C*, and granules of carbon *G*. These parts are found in the different types, although they may vary considerably in detail. The transmitter is used to vary the currents sent out on the line in accord with the vibrations set up by the words spoken into it. The diaphragm *D* forms one side of the circuit through the containing case *AB*, the other being formed by the carbon granules *G* through the carbon block *C*, which is held in place by the fixing screw *S*, insulated from the case as shown in Fig. 3.

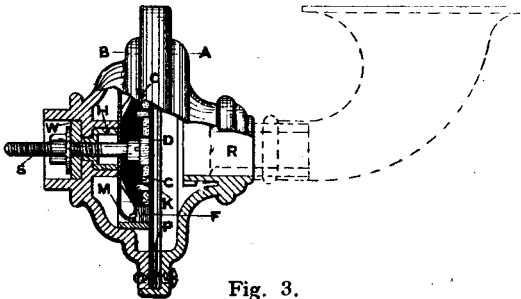


Fig. 3.

In this type of transmitter the aluminium containing case *A* and *B* is made in two parts. The part of the case *B* has a recess into which fits a round carbon block, *C*, $\frac{1}{8}$ in. in diameter and $\frac{1}{4}$ in. thick. The face of this block has seven holes drilled in it; the one in the centre is cut right through and is made large

enough to take the long clamping and connecting screw. The spacing of the holes is shown in Fig. 3a, which gives a separate view of the carbon block.

Tufts of cotton-wool are fitted in each of the seven holes. These tufts when in position press lightly on the carbon diaphragm *D* (Fig. 3), which is $2\frac{1}{4}$ in. in diameter and 40 mils thick. A sleeve of soft felt *F* fits over the edge of the carbon block, and is also pressed lightly against the diaphragm by the heads of six bronze springs, which are all joined together at the centre and clamped with the carbon block, six recesses being made in the latter to allow the springs to work freely.

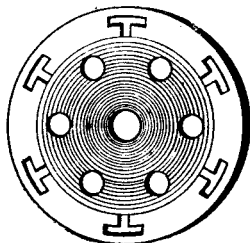


Fig. 3a.

The carbon block and screw *S* are insulated from the case *B* by a mica washer *M* and bush *H*, and by an ebonite washer *W* at the back. Rings of blotting paper *P* are used to clamp the diaphragm, and they also serve to clamp in front a membrane of oiled silk *K*, which prevents the moisture from the breath, etc., reaching the diaphragm. An ebonite mouthpiece shown in dotted lines on the figure fits into the recess *R*. About five grammes of carbon granules *G* are put in the recess left at the back of the diaphragm.

Another form is similar to this as regards the carbon block (except that the six outer holes in the block are missing), but the diaphragm is of ferrotype iron (about 12 mils thick) on the inner face of which is fitted a gilded metal disc, the surface of which has over thirty indentations pressed into it in two concentric rings. These project into the carbon granules, making good contact between the diaphragm and granules while preventing packing, this purpose being served in the first form by the tufts of cotton-wool.

Another type, generally known as the Deckert, is distinguished by the special form in which the carbon block is made up. This is shown in Fig. 4.

A number of square-based pyramids are formed, arranged so that the junctions of the bases of the pyramids in one row are opposite the middle lines of the bases in the adjoining rows. Only the centre portion of the block is used, the other part

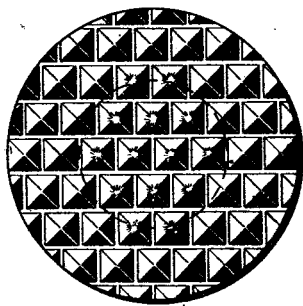


Fig. 4.—CARBON BLOCK OF DECKERT TRANSMITTER

being covered with a thick pad of cotton-wool. All the tips of the pyramids in a circle of about 1 in. diameter are cut off and little tufts of floss silk are attached. These serve to prevent short-circuiting against the carbon diaphragm, also to damp the vibrations of the latter and to prevent packing by retaining some of the granules of carbon entangled among the filaments. As this type is not altogether free from packing, it is generally arranged to fix the transmitter so that it may be rotated a half-turn occasionally when used as a "fixed" transmitter.

To get satisfactory working in both the receiver and transmitter it is necessary that the diaphragm should, in both, be rigidly fixed around the outer edge, the centre part being free to vibrate readily in response to the varying currents in the coils of the receiver in the one case, and to the vibrations of the air set up by the words spoken into the transmitter in the other. It will at once be clear from this how important the adjustment of the diaphragm is in both parts of the set.

3. The standard battery to be used in connection with magneto instruments is the Leclanché wet cell, of which two are required to give a satisfactory supply of current to the transmitter. The cells are joined in series. That is, the zinc of No. 1 is joined to the carbon of No. 2; the carbon of No. 1 and zinc of No. 2 are then connected to the one side of the transmitter and one side of the primary of the induction coil respectively.

4. The last item on the speaking portion of the set is the Induction Coil, so called because its purpose is to step up to high voltages, by induction, the low voltage currents passing through

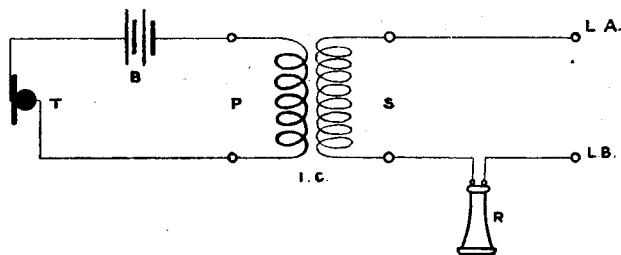


Fig. 5.—CONNECTIONS OF INDUCTION COIL

the transmitter, while keeping the resistance and voltage on the circuit containing the transmitter, low.

It is made up of two coils, one known as the *primary*, with few turns, the other having many turns and known as the *secondary*. These coils are of insulated wire and are wound one over the other. The bobbin has a soft iron core usually formed of a bundle of short pieces of iron wire.

The complete connections of the various parts are shown in simple form in Fig. 5.

It will be seen that the transmitter *T*, battery *B*, and primary winding *P* of the induction coil *IC* form a complete circuit insulated from the line, so that all currents which circulate on the line are those set up by induction in the secondary winding *S* of the induction coil and pass through the receiver *R* and the line terminals *LA*, *LB*.

A switch is provided to prevent the battery from running down and the energy given out by it from being wasted while

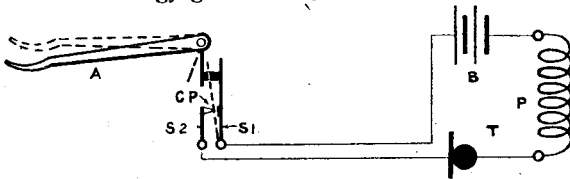


Fig. 6.—CIRCUIT CONNECTIONS OF SWITCH HOOK.

the telephone is not in use. This switch, as one of its details, forms the hook or rest on which the receiver is placed when not in use. The switch is automatic in its working, that is to say, the lifting of the receiver completes the connection from one side of the battery to one side of the transmitter, the other side of which is permanently connected to the primary of the

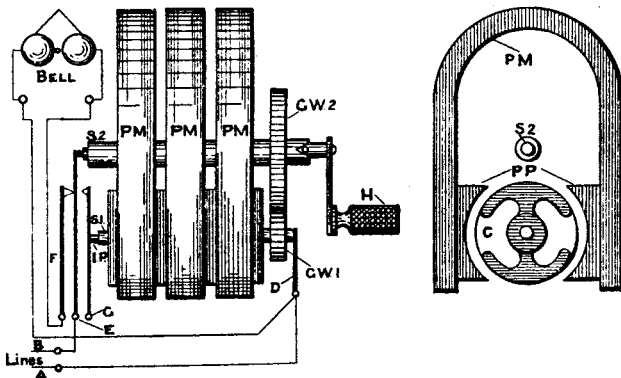


Fig. 7.—CONNECTIONS OF GENERATOR

induction coil; the other side of the battery is also permanently connected to the induction coil. The essential parts of one such type of switch are shown in Fig. 6.

The position of the arm *A* when the receiver is on the hook is shown in full lines, being held down against the push of the

spring S_1 by the weight of the receiver, thus keeping the contact points CP apart and the circuit open. Immediately the receiver is lifted, however, the push of the spring S_1 raises the arm A and closes the contact point against the spring S_2 . Figure 6 also shows the connection through the switch from transmitter T to battery B .

5. The generator is of the magneto type from which the set of apparatus takes its name as well as the method of working. It consists of three permanent horse-shoe magnets PM (Fig. 7) fitted with pole pieces PP , a coil of insulated wire G wound on an iron frame, as a core, through which is fitted a shaft S_1 with a small geared wheel GW_1 ; a second shaft S_2 fitted with a larger gear wheel GW_2 and a handle H are also provided. One end of the coil is terminated on an insulated pin IP fixed at one end of the shaft, the other end of the coil being connected to the shaft itself.

By turning the handle the coil can be rapidly rotated within the space between the pole pieces. This generates the alternating currents which operate the signal at the other end of the line.

6. The bell consists of two coils, C_1 , C_2 (Fig. 8) with soft

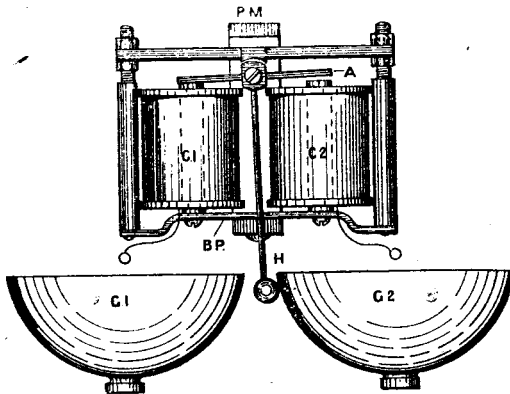


FIG. 8.—MAGNETO BELL.

iron cores and bridge piece BP , and an armature A polarised by means of the permanent magnet PM . The armature, to which the hammer H is attached, is pivoted and free to move about its centre, thus permitting the hammer to strike the gongs G_1 , G_2 with a to and fro movement, as the alternating currents, passing through the coils, cause each end of the armature to be alternately attracted and repelled by the change of polarity in the cores.

To the generator is fitted an automatic cut-out, one type of which is illustrated in Figs. 7 and 9. When at rest, spring F is in

contact with spring *E*, and one end of the generator coil terminated on the insulated pin *IP*. This pin is in contact with spring *G*, which is disconnected from the line. The bell, one side of which is connected to spring *F* is, however, in circuit on line *B* through spring *E*. Spring *D*, which is in contact with the shaft *S1* carrying the other end of the generator coil, forms a common connection to line *A* for both the generator and the other side of the bell coils.

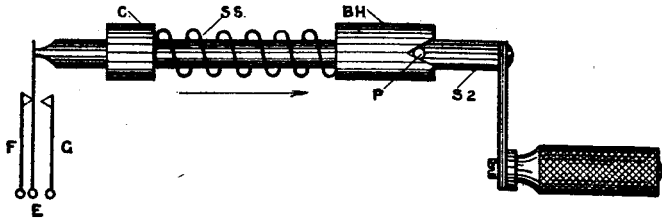


Fig. 9.

When the handle of the generator is turned the shaft on which the handle is fixed is moved in the direction of the arrow (Fig. 9) by the pin *P* riding up the V-shaped groove on the bush *BH* against the pull of the spring *SS* fixed on the shaft by the collar *C*. The spring *E* follows the shaft, thus breaking contact with *F* (to which one side of the bell coil is connected), and makes contact with spring *G*. The generator is then in circuit on the line as follows: Line *B*, springs *E* and *G*, the insulated pin (to which one side of the generator coil is connected), generator coil, spring *D* and line *A*. The bell is disconnected.

CONNECTIONS.

The connections of magneto telephones are generally arranged on one of two plans.

(1) **Shunting type.** The speaking and ringing apparatus are arranged in series. The action of the receiver switchhook is to short-circuit the speaking portion of the apparatus while the receiver is at rest and to short-circuit the ringing apparatus when the receiver is lifted to speak (see Fig. 10).

(2) **Disconnecting type.** When the receiver is at rest the switchhook completes the ringing circuit and keeps the speaking circuit disconnected. When the receiver is lifted it disconnects the ringing circuit and joins up the speaking circuits (see Fig. 11).

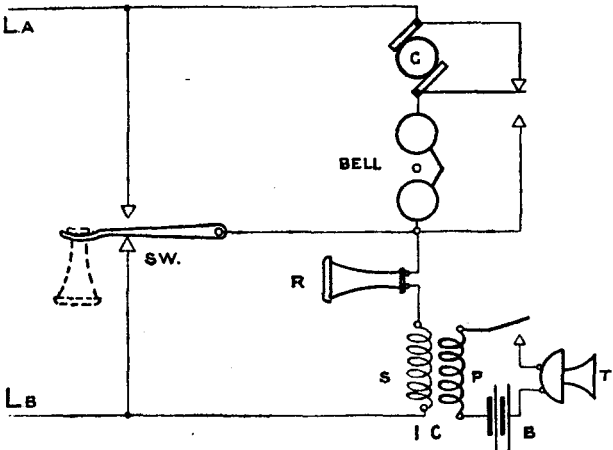


Fig. 10.—CONNECTIONS OF MAGNETO TELEPHONE—SHUNTING TYPE.

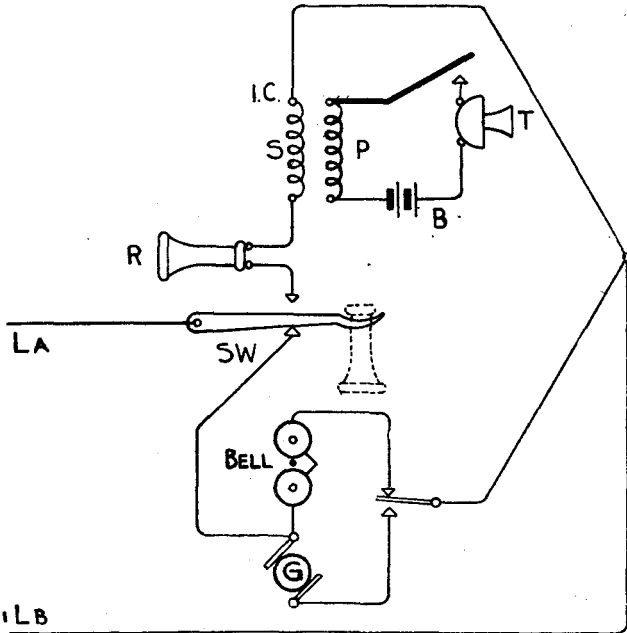


Fig. 11.—CONNECTIONS OF MAGNETO TELEPHONE—DIS-CONNECTION TYPE.

The detailed connections of such a set are shown in Fig. 12. The heavy dotted lines indicate the speaking circuit with the transmitter *T*, battery *BY* and the primary *P* side of the induction coil.

The full heavy lines show the listening circuit through the receiver *R*, switch *SW*, and the secondary *S* of the induction coil. The full thin lines show the connections of the bell *PB* and the

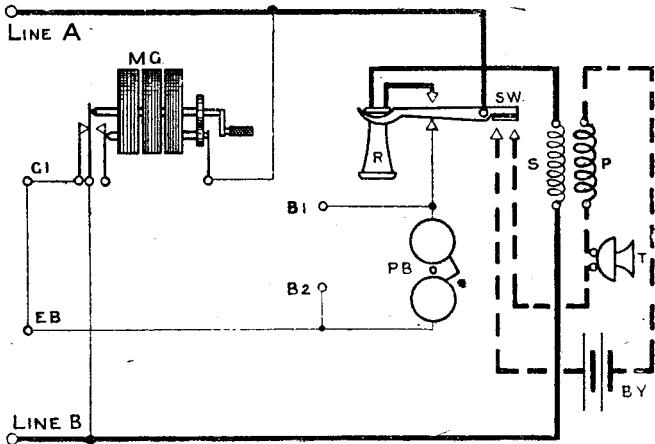


Fig. 12.—COMPLETE CONNECTIONS OF A SUBSCRIBERS' MAGNETO SET.

generator *MG* to line. The terminals *B1* and *B2* are used when an extra bell is required.

Loose Leaf Diagram N.111 shows the connections on telephone No. 11 (Mark 238) for magneto working. It is a wall set, the general appearance of which is shown along with the complete wiring diagram.

Another type of instrument, a table set, is illustrated in Loose Leaf Diagram N.116, which shows telephone No. 16 with hand micro-telephone, the receiver (of the watch type) and transmitter being mounted on one handle, which has, on the grip, a switch used for connecting the battery to the transmitter and the primary of the induction coil when held in the hand and pressed. The general appearance of this set is shown as well as the complete wiring diagram. The terminals for the transmitter and receiver connections from the cord of the hand micro are fitted on the slab which carries the pedestal and the cradle on which the hand micro is placed when not in use. The line, battery and extension bell terminals on the terminal strip are

carried to terminals fixed on the opposite side of the slab from those carrying the hand micro cord connections.

Three other types of magneto instruments in common use are:—

- (1) A Wall Telephone Set No. 59—Loose Leaf Dia. N.159.
- (2) A Table Set No. 88—Loose Leaf Dia. N.188.
- (3) A Table Set, Telephone No. 4, Bell Set No. 5, Generator No. 4 C.N.—Loose Leaf Dia. N.505, Sheet 2.

EXTENSION BELLS.

Sometimes, in addition to the bell at the telephone station itself, it is required to have another bell placed at some distance away, so that, in the event of no one being in constant attendance where the telephone is fitted, attention may be called by the ringing of the second bell. The bell provided for this purpose is similar in construction to that shown in Fig. 8, and is

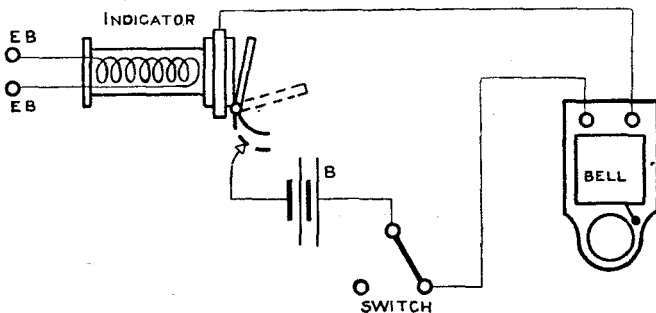


Fig. 13.—EXTENSION BELL CIRCUIT WITH INDICATOR.

enclosed in a wooden case with the gongs outside. Connection is made to this bell from the terminals marked *EB* in the various wiring diagrams of telephone sets. Where a strap is shown across terminals so marked it is removed when the extension bell is connected.

In other cases, where it is desired to have a continuous ringing arrangement, an indicator is inserted in place of the

polarised bell. To the bell contacts of the indicator shutter a trembler bell is connected with a battery as shown in Fig. 13.

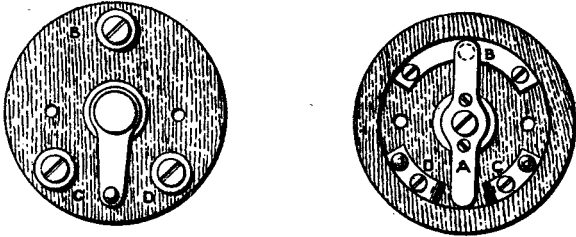


Fig. 14.—Two-WAY SWITCH.

A two-way switch (Fig. 14) is also fitted in this circuit, so that when desired, the bell may be disconnected in order to prevent the battery being run down should a call be made from the exchange when no one is in attendance. A two-way switch may also be fitted with the polarised bell when it is desired to throw the bell out of use at times.

EXTENSION CIRCUITS.

When more than one telephone is required in connection with an exchange line, the first telephone, *i.e.* that at which an incoming ring is normally received, is referred to as the **main station**. The second and subsequent telephones are known as **extensions**.

When full intercommunication between one extension and another is required, a switchboard is fitted at the main station and the installation becomes a Private Branch Exchange. To meet the requirements in those cases where full intercommunication is not required between one extension and another or where only one extension is required, a series of standard arrangements has been designed each of which is given a Plan number.

The following is a brief description of each of the arrangements and a reference to the diagrams concerned.

Plan 1.

Loose Leaf Diagram N.1440, gives a diagrammatic representation of this arrangement which is provided on internal

extensions only. The circuit connections with various types of telephone are :—

Diagram No.	Main Station.	Extension 1.	Extension 2.
N.1380	Telephone No. 4	Telephone No. 4	Telephone No. 4
N.1381	" 4	" 4	" II
N.1382	" 4	" II	" II
N.1383	" II	" II	" II
N.1384	" II	" II	" 4
N.1385	" II	" 4	" 4

One magneto bell only is provided for the receipt of incoming rings and this is fitted at the main station.

Each extension telephone is connected in parallel with the main station; any conversation can, therefore, be overheard on any telephone. Any extension can call the exchange direct by hand generator but all the telephones are connected permanently in parallel on the exchange line. Inter-communication between one extension and another, or between an extension and the main station, is not available.

To enable the main station to signal an extension when required on an incoming call, trembler bells are provided at extension points with corresponding press buttons at the main station.

Plan 1A.

Loose Leaf Diagram N.1441 gives a diagrammatic representation of this arrangement which is provided on internal extensions only. The circuit connections with various types of telephone are :—

Diagram No.	Main Station.	Extension Station.
N.1386	Telephone No. 4	Telephone No. 4
N.1387	" 4	" II
N.1388	" II	" II
N.1389	" II	" 4

A magneto bell is provided at each station. At the main instrument the bell is permanently connected in circuit. At the extension the bell is controlled by a switch, thus providing an arrangement whereby an incoming ring may be received when desired at the extension as well as at the main station.

The extension telephone is connected permanently in parallel with the main station, and calls the exchange direct by hand generator; neither secrecy nor intercommunication is available.

Plan 2.

No arrangement with this number has been standardised.

Plan 3.

Loose Leaf Diagram N.1442 gives a diagrammatic representation of this arrangement which is provided on internal extensions only. The circuit connections with various types of telephone are:—

Diagram No.	Main Station.	Extension.
N.1390	Telephone No. 4	Telephone No. 4
N.1391 .. ..	.. 4	.. 11
N.1392 .. ..	.. 11	.. 11
N.1393 .. ..	.. 11	.. 4

In the normal condition, the exchange line is connected *via* a switch at the extension to the main station. The main station calls the extension when required by means of a press button and trembler bell.

At the extension station the talking circuit is connected permanently to the exchange and, with the switch in the normal position, is in parallel with the main telephone. The magneto bell at this point is normally out of circuit.

Should the extension desire to cut out the main station and thus obtain secrecy on an exchange call, this can be done by the operation of a 6-point 2-position switch. This switch also completes the circuit of the magneto bell at the extension, and if the switch is left in the operated position any incoming ring will be received at the extension instead of at the main.

Intercommunication is not available.

Plan 4.

Loose Leaf Diagram N.1443 gives a diagrammatic representation of this arrangement which is provided for the internal extension only of a line. The circuit connections are shown in N.1394.

The exchange line is connected to a bell and jack at the main station. A Telephone No. 16 or 88 is terminated on a plug and connection between the telephone and the exchange line is established by means of additional jacks fitted in any required positions.

Plan 5 or 5A.

A diagrammatic representation of this arrangement is shown in Loose Leaf Diagram N.1444 and the circuit connections in the following diagrams.

Diagram No.	Main Station.	Extension 1.	Extension 2.
N.1395	Telephone No. 4	Telephone No. 4	Telephone No. 4
N.1396	" 4	" 4	" II
N.1397	" 4	" II	" II
N.1398	" II	" II	" II
N.1399	" II	" II	" 4
N.1400	" II	" 4	" 4

These arrangements are a combination of Plan 7 or 7A and Plan 1A with slight modification, and are provided on internal extensions only.

The bells of the extensions are not connected across the line, but to a third wire which is run from each extension to the main station where it is connected to a press button. With this arrangement the main station can ring either extension as desired by using the hand generator.

When the switch at the main station is in the through position, either of the extensions can call the main exchange direct. In any other position of the switch the extensions call the main. As stated above, the bells at the extensions are not normally connected across the line, but should direct service at night to the main exchange be required from one (and only one) of the extensions, a switch can be fitted there to bring the bell into circuit when required.

Secrecy at the main station against the extension stations is provided for but the extensions are not secret against each other. The connections on the switch at the main station shown on the diagrams quoted are those required by Plan 5A whereby the extension stations are secret against the main station. If a Plan 5 arrangement is required, i.e., if the extensions are not to be secret against the main station, alterations to the connections on the switch at the main station as indicated on the diagrams are necessary. The difference between the two plans is dealt with in detail in connection with Plans 7 and 7A.

Plan 6.

No arrangement has been standardised with this number.

Plans 7 and 7A.

A diagrammatic representation of this arrangement is shown in Loose Leaf Diagram N.1445 and the connections in the following diagrams.

Diagram No.	Main Station.	Extension.
N.1401	Telephone No. 4	Telephone No. 4
N.1402 .. ..	.. 4	.. II
N.1403 .. ..	.. II	.. II
N.1404 .. ..	.. II	.. 4

At the main station a combined switch and bell known as a "Switch N.T.14" is fitted and to this are connected the exchange line, the extension and the main station telephones. There are three positions of the switch, namely

Main to Exchange.

Exchange to Extension.

Main to Extension.

With the Plan 7A arrangement the switch is fitted as supplied and in none of the three positions can conversation be overheard on the remaining circuit. This arrangement, therefore, gives full intercommunication and secrecy.

In the Plan 7 arrangement the connections to the telephone and the bell of the switch are reversed, as are also the exchange line and extension. The three talking positions of the switch remain as in Plan 7A, but in the exchange to extension position the main instrument is in parallel and the arrangement is, therefore, non-secret on such conversations. The advantage of this arrangement is that the main station is able to supervise the setting up of a connection between the extension and the public system.

In both the Plan 7 and Plan 7A arrangements, the extension is connected to a bell when the exchange is connected to the main telephone, or the exchange is connected to the bell when the extension is connected to the main telephone. With the switch in the "Exchange to Extension" position on the Plan 7A arrangement, the bell is connected across the circuit to act as a ring-off signal, or as a calling signal should a subsequent call mature with the switch in the through position.

Both Plan 7 and Plan 7A arrangements are suitable for use on either internal or external extensions.

Plan 8.

A diagrammatic representation of this arrangement is shown in Loose Leaf Diagram N.1446 and the circuit connections in N.1405.

This arrangement provides for one common extension on two exchange lines. Each exchange line is permanently connected to a separate main instrument and from each line connections are made to the contacts of a special switch at the extension. The extension telephone is also wired to this switch and is connected to one exchange line or the other in accordance with the position of the switch.

The magneto bell of the extension telephone is not connected, all incoming rings being received at the main station. To enable the main station to signal the extension when required, press buttons are provided at the main telephones and connected to trembler bells of different tones at the extension.

The arrangement does not provide secrecy or inter-communication and is fitted on internal extensions only.

Plan 9.

A diagrammatic representation of this arrangement is shown in Loose Leaf Diagram N.1447 and the circuit connections in N.1406.

This arrangement provides means whereby a subscriber on a P.B.X. extension telephone may use the same instrument to make an independent enquiry over a second line without releasing the first connection.

Two extension lines to the P.B.X. are provided and both are connected to calling equipments on the switchboard but no bell is provided on the second line at the extension station. Calls may thus be originated over either line but incoming calls cannot be effected over the second.

A key is provided at the extension and in the normal position of this key the telephone is connected to the first line whilst the second is left disconnected. The first line is normally used for both incoming and originated calls.

The operation of the key transfers the extension telephone to the second line and connects a bell directly across the first line. The second line can then be used for the purpose of making enquiries or calls whilst an incoming call is held on the first. The use of a bell as a holding device enables the extension to be rung if the key is accidentally left in the operated position.

Plan 10.

A diagrammatic representation of this arrangement is shown in Loose Leaf Diagram N.1448 and the circuit connections in N.1407.

In this arrangement the line or lines from the main exchange to the P.B.X. are connected *via* break jacks at the extension point where the telephone is terminated on a plug. The extension line from the P.B.X. is also connected to a jack, the inner springs of which are wired to a bell (and condenser if required).

In the normal condition the telephone plug is kept in the extension jack and all calls are effected *via* the extension line in the usual way. Should the extension station desire to obtain secrecy on an exchange call, the telephone plug can be transferred to the jack of the particular exchange line on which the connection has been established.

It is not intended that calls should be originated directly on an exchange line as no intimation is given at the P.B.X. when a plug is in an exchange line jack at the extension, and any attempt on the part of the switchboard attendant to make a call on the same exchange line would be unsuccessful.

In order, however, that an indication may be given at the P.B.X. of an incoming ring on any exchange line left plugged up at the extension point a second bell is connected in series with the telephone bell of the extension and fitted adjacent to the P.B.X. switchboard. This bell is short circuited when the telephone plug is in the extension jack.

The arrangement is fitted on internal extensions only.

Plan 11.

A diagrammatic representation of this arrangement which is fitted on internal extensions only is shown in Loose Leaf Diagram N.1449 and the circuit connections with various types of telephone in the following diagrams.

Diagram No.	Main Station.	Extension 1.	Extension 2.
N.1408	Telephone No. 4	Telephone No. 4	Telephone No. 4
N.1409	" 4	" 4	" 11
N.1410	" 4	" 11	" 11
N.1411	" 11	" 11	" 11
N.1412	" 11	" 11	" 4
N.1413	" 11	" 4	" 4

In this arrangement, as in Plan 1, the extensions are provided in parallel with the main telephone; no secrecy or intercommunication is, therefore, provided.

A magneto bell is provided at the main station only and all incoming rings are, therefore, received at that station.

A local bell circuit is provided from a push at the main station to a bell at the first extension and a second local bell circuit is similarly provided from the first to the second extension.

All incoming calls are thus dealt with primarily at the main station, then if necessary the first extension can be called into circuit and finally the second extension if required can be signalled from the first.

Any station can originate outgoing calls direct to the main exchange.

COIN COLLECTING BOXES.

Where no attendance is given for the collection of fees at public telephone stations a coin collecting box is fitted alongside the telephone. It is so connected on the exchange line that when a penny is inserted in the slot and the handle at the side of the box turned, a signal in the form of a buzzing sound is given on the line to the operator listening at the exchange.

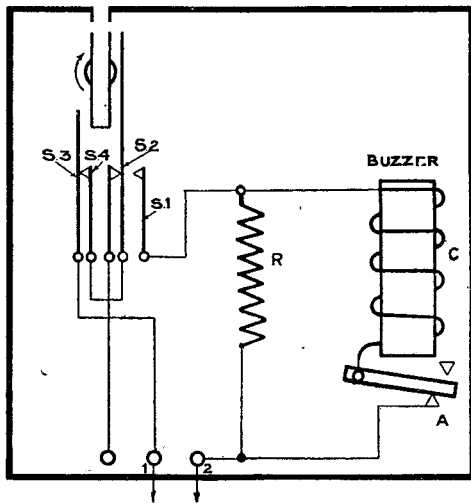


Fig. 15.—COIN COLLECTING BOX CONNECTIONS.

The connections of the apparatus are shown in Fig. 15. The buzzer is formed of a coil C wound on a soft iron core having

an armature *A* free to move between the two contact points. The resistance *R* is a shunt across the buzzer to reduce its tone which would otherwise be objectionably loud to the telephonist and the caller. The action of the buzzer is similar to that of an ordinary trembler bell. If reference be made to Loose Leaf Diag. N.111 it will be seen there are two terminals marked *CB*, *CB*, and it is to these two terminals that connection is made from terminals 1 and 2 of the coin collecting box. From one of the terminals marked *CB* on the telephone instrument connection is made to one side of the primary of the induction coil, and the other terminal so marked is connected to the battery. When a coin is placed in the slot of the coin collecting box and the handle turned, an arrangement of the mechanism causes spring *S*₂ to make contact with spring *S*₁. In this way one side of coil *C* is connected to one of the telephone terminals *CB*, through *S*₁, *S*₂, *S*₄, *S*₃, and terminal 1; the other side of the buzzer coil being connected through the armature and lower contact to terminal 2, and so to the second terminal marked *CB* on the telephone.

Current then passes from battery on the telephone set through the primary of the induction coil, the buzzer in the coin box, and back to the battery. Immediately this takes place the armature *A* is drawn up from the contact point, thus breaking the circuit, which is, however, again made by the armature falling back against the contact. By this means a rapid make and break takes place in the circuit containing the primary of the induction coil, causing a similar make and break of current in the secondary by induction, and so to the line to which the secondary is connected, thus giving the buzzing sound required to advise the operator at the exchange that the penny has been placed in the slot and the handle turned. The mechanism in the box is so arranged that, until the penny is placed in the slot and drops into the carrier below it, the turning of the handle does not complete the circuit through the springs, etc., and the buzzer is not actuated. When the handle is turned to its fullest extent the penny is released by the mechanism and falls into the containing box below; the springs then return to the normal position, and the circuit through the buzzer is broken.

APPARATUS FAULTS.

Trouble in connection with the **Receiver** is chiefly caused by the adjustment between the diaphragm and the pole pieces being disturbed (generally due to mishandling of the apparatus). The ear cap which holds the diaphragm in place may have worked loose and requires to be screwed up tight. The diaphragm may have been buckled or dented by some mechanical means such as the sticking of a pencil through the orifice in the ear cap. In this case the free movement of the diaphragm is interfered

with and the diaphragm should be changed. Care should be taken to see that the adjusting ring is properly placed in position before fixing on the ear cap.

The Transmitter is liable to get out of adjustment by the carbon granules being shaken out of place so that they do not make proper contact with the surface of the diaphragm. Trouble is also caused by "packing," that is, a settlement of the granules in one part in such a way as to bear hard on the diaphragm, thereby preventing its free vibration when the transmitter is spoken into. Where the Deckert form of transmitter is in use speech may be improved by giving the transmitter a half turn to loosen the granules. It is, however, generally better to replace the faulty transmitter and to send it to the workshop or other place where there are facilities for testing it after adjustment through standard apparatus.

The flexible cords, which are used in completing connection with the receiver and with both receiver and transmitter when a hand micro-telephone is used, are a frequent source of trouble, the conductors contained in the cords becoming either partially or totally disconnected. A partial disconnection can be readily detected by lightly shaking the cord while listening or speaking. In table sets such as Tele. No. 4, No. 16 and No. 88, the flexible cords between the terminal block and the apparatus are liable to cause trouble in the same way as the cords to the receiver and hand micro-telephone.

The Induction Coil having no moving parts is not subject to any frequent trouble. Any disconnection in, or contact between, the primary and secondary coils seldom occurs. Such faults may readily be traced by the use of the Detector and battery.

The principal cause of failure in the generator is usually found at the cut-out, where the springs may get out of adjustment and cause either a disconnection or short circuit; a slight adjustment of the springs will generally clear the trouble. Oiling is necessary to allow of free and noiseless running, but it should be done carefully and sparingly, otherwise the oil will run from the bearings on to the springs of the cut-out or the windings of the coil. A special oil is provided for this purpose, and no other should be used.

In connection with the Bell the most frequent trouble arises from disturbance of the adjustment of the armature and hammer. The adjustment should be so made that the armature is free to move readily on its pivot about its centre and that the hammer is free to strike either gong.

Trouble seldom arises from the permanent magnets in any portions of the apparatus losing their magnetism. This can readily be tested in the receiver by the pull of the magnet on the diaphragm, and in the bell by testing the strength with which the armature is held against either core when moved by hand.

Faults sometimes arise through the springs of the automatic switch of the receiver rest getting out of adjustment. This may cause a failure to complete the contact when the receiver is taken off the rest or a permanent disconnection when the receiver is hung up.

In the intermediate, through or private switch trouble is almost entirely confined to the springs, which may get out of adjustment and cause disconnection or prevent the free movement of the cam.

Coin-collecting boxes are most frequently put out of order by the use of bent pennies, which stick in the slot, or in the carrier which throws the penny free when the buzzer has been operated. Trouble is occasionally caused by the springs of the buzzer getting out of adjustment and preventing a proper make and break of the current through the coil.

MAINTENANCE.

All parts of the apparatus should be kept clean and as free from dust as possible both inside and out. Special care should be taken to see that all contacts are thoroughly clean, otherwise total or partial disconnection is likely to take place at these points.

All terminals should be firmly screwed up to ensure good electrical connection being made. To permit of this being satisfactorily done, not only should the connecting surfaces of the terminals be bright and clean, but the wire, where bared of insulation, should also be thoroughly cleaned and neatly looped under the head of the terminal or screw. The insulation should be cut as close to the point of fixing as possible so that no more bare wire than is absolutely necessary is left outside the head of the terminal, otherwise trouble may arise from contact with some other bare wire or metal connection.

For similar reasons all soldered connections should be examined to make sure that they are good both electrically and mechanically. No dry joints should be left on wires under any circumstances. All joints should be clean and carefully soldered. Where joints are made on insulated wires the joint should be carefully covered with the insulating material provided for the purpose, so that the insulation of the joint is equal to any other part.

It is false economy to dispense with any of the tools specially provided for dealing with the various parts of the apparatus; for instance, a large screwdriver should not be used for small screws. Special care must be taken in adjusting springs to avoid bending them so that they lose their proper shape or their temper and elastic qualities, as, in such cases, they are likely to be a constant source of trouble.

All wires should be neatly fixed by proper stapling to ensure a tidy appearance. Loose wires may foul each other or some fitting. Care should be taken not to drive the staples into the covering so hard as to destroy its insulating qualities and to bring the staple into electrical contact with the conductor.

When a fault is reported on a subscriber's apparatus an indication is generally given as to the nature of the trouble. For instance :—

1. *Subscriber cannot hear.* In this case the fault should first be sought for in the receiver, and then from that point through the cord to the secondary of the induction coil.

2. *Subscriber cannot be heard.* The trouble should first be sought at the battery, then through the cord (if one is in use), the automatic switch, and the primary of the induction coil to the transmitter.

3. *Subscriber cannot be called.* Attention should be given to the bell connections, through the cut-out at the generator and switch.

4. *Subscriber cannot call exchange.* Attention should be given to the connections of the generator through the cut-out.

5. *Out of order,* or the trouble is such as cannot be particularly defined. The proper course to be pursued is first to call the exchange if possible. If this cannot be done proceed as in 4. If attention is obtained and speaking and hearing are both good, proceed to test the bell by getting the exchange to ring; if this is unsatisfactory proceed as in 3. If speaking is faulty proceed as in 2, and if hearing is faulty proceed as in 1.

The maintenance of the primary batteries at the subscriber's telephone is of the utmost importance, as on this depends the quality of speech obtained. If the zinc or porous pot becomes coated with a deposit of any kind, or if the solution becomes weak or is allowed to fall much below the top of the porous pot, the internal resistance of the battery rapidly increases and the current supplied to the transmitter consequently falls. Speech at once becomes faint, causing serious difficulty in carrying on conversation, if not completely preventing it.

The principal points to be observed in the maintenance of wet cells are :—

1. That the surface of the zinc is kept clean and free from any deposit of crystals from the solution.

2. That the surface of the porous pot is free from deposit of crystals.

3. That the terminals are clean where the surface makes contact with the connecting wire. They should be carefully cleaned when connection is made, and should be firmly screwed up to prevent loose connections.

4. That the zinc is connected to the wire by a butterfly terminal.
5. That adjacent cells do not touch.
6. That the outsides of jars are left clean and dry.
7. If the liquid appears concentrated, water should be added to make good evaporation.
8. If the solution appears weak, sal-ammoniac or chloride of manganese should be added, care being taken to see that it is dissolved.
9. The solution should be kept sufficiently high so that the jar is three-fourths full.
10. The solution should not be splashed about, as it has a very corrosive effect on all metal parts.
11. The zinc should be so inserted that it can be readily seen on inspection.

The maintenance of Primary Batteries is fully dealt with in Technical Pamphlet A2.

CELLS.

The question as to which type of cell should be used is generally determined by the position in which the cells are to be placed. In the case of Wall Sets, where the cells can be placed in the space provided for them in the instrument, wet cells should invariably be used. Wet cells should also be used where the battery is fitted away from the instrument, and can be placed on a shelf or in a locker where the cells are not likely to be upset.

As a general rule, dry cells should be used only in positions where there is risk of the cells being upset, or where the temperature is such as to cause excessive evaporation of wet cells.

LIST OF Technical Pamphlets for Workmen

(Continued)

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19. Cord Repairs.
20. Superposed Circuits. Transformers. Bridging Coils and Retardation Coils.
21. Call Offices.
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GROUP E.

1. Automatic Telephony : Step-by-Step Systems.
2. Automatic Telephony : Coded Call Indicator (C.C.I.) Working.
3. Automatic Telephony : Keysending " B " positions.

GROUP F.

1. Subscribers' Apparatus. Common Battery System.
2. Subscribers' Apparatus, C.B.S. Part I—C.B.S. No. 1 System.
3. Subscribers' Apparatus. Magneto.
4. Private Branch Exchanges—Common Battery System.
5. Private Branch Exchanges—C.B. Multiple No. 9.
6. Private Branch Exchanges—Magneto.
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8. Wiring of Subscribers' Premises.

GROUP G.

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2. Power Plant for Telegraph and Telephone Purposes.
3. Maintenance of Power Plant for Telegraph and Telephone Purposes.
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2. Open Line Construction, Part II.
3. Open Line Maintenance.
4. Underground Construction, Part I—Conduits.
5. Underground Construction, Part II—Cables.
6. Underground Maintenance.
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8. Power Circuit Guarding.
9. Electrolytic Action on Cable Sheaths, etc.
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GROUP I.

1. Submarine Cables.

GROUP K.

1. Electric Lighting.
2. Lifts.
3. Heating Systems.
4. Pneumatic Tube Systems.
5. Gas and Petrol Engines.

GROUP L.

1. " Safety First " for P.O. Engineering Workers.