P.W.—A.4.

POST OFFICE
ENGINEERING DEPARTMENT

TECHNICAL PAMPHLETS FOR WORKMEN

Subject :

TEST BOARDS.

ENGINEER-IN-CHIEF'S OFFICE
1919

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Technical Pamphlets for Workmen.

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TEST BOARDS

(A.4).

The following pamphlets in this series are of kindred interest:—

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A. 6. Measuring and Testing Instruments.

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TEST BOARDS.

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TEST BOARDS.

GENERAL PRINCIPLES.

Test Boards are provided (1) for concentrating and controlling open and underground lines terminating at, or passing through, an office, (2) to allow of the several sets of sending and receiving apparatus fitted at that office to be joined up as required to any line connected to the Test Board, and (3) to enable rearrangements of circuits to be readily made.

A telegraphic circuit consists of (a) an insulated wire connecting the sending and receiving stations, (b) the wire of the receiving station apparatus, (c) the "earth return," which conveys the current back to the sending station, and (d) the wires

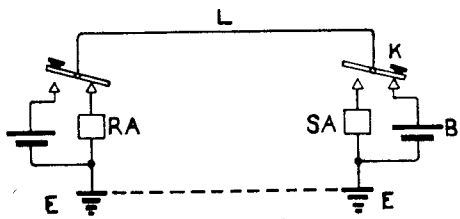

Fig. 1.

to the battery at the sending station. In the diagrammatic Fig. 1, *L* is the insulated open or underground line-wire, *RA* the receiving station's receiving apparatus, *E* the "earth return," and *SA* the sending station's apparatus with sending key *K* depressed. *B* is the sending station battery.

Any failure in signalling on a circuit is a fault. To restore the circuit to good working condition, both the cause of failure and the point at which the fault has taken place must be ascertained. The failure may be due (1) to the condition of the line-wire, or (2) of the apparatus, or (3) of the battery. It is necessary, therefore, to provide some easy but efficient means of separating the circuit into these three main parts. Suppose that, instead of taking the line and battery wires direct to the apparatus, as in Fig. 1, we introduce into the circuit at some convenient point in the office a series of terminals which can be either connected by metal straps or lengths of wire, or which may be "freed" as required. Fig. 2 shows Fig. 1 redrawn, but introducing terminals *T* connected by metal straps *S*.

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Comparing Figs. 1 and 2, it will be seen that if all the terminals and strap connections are clean and firmly made the circuits are identical. But we now have a means of readily separating the circuits at each end into the three component parts of line, apparatus and battery. Take the sending station end of Fig. 2 :—

(1) by removing strap *S*1 the line may be disconnected from the apparatus and battery;

(2) by removing strap *S*2 the apparatus and battery may be disconnected from the " earth return ";

(3) by removing straps *S*3 and *S*4 the battery may be disconnected from the apparatus.

Similar operations may be carried out at the receiving end of the circuit.

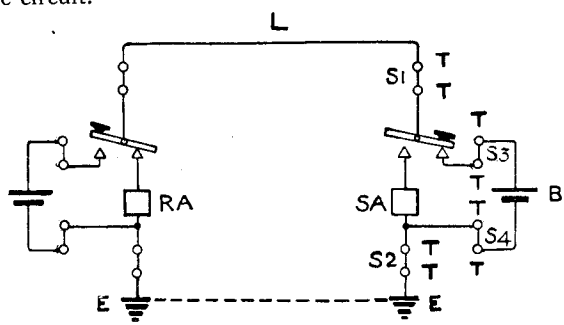

Fig. 2.

This series of terminals and straps is the underlying principle of the arrangement of all Test Boards.

The older forms of Test Boards are fitted with brass terminals and straps, but owing to the large amount of space necessarily taken up by this class of fitting the use of such Test Boards is confined to those offices where the number of lines to be dealt with is small. At offices where a large number of lines is dealt with, other patterns and smaller fittings are made use of with great economy of space. Also, in large offices where many systems and arrangements of apparatus are fitted, modifications have been introduced, all tending to simplify the location of faults or the rearrangement of circuits. The older form of Test Board is, however, more simple in construction, and the working conditions are more easily understood. A description of the old form still in use by the Post Office will be given, and the study will be helpful when considering the modern types of Test Boards.

TEST BOX FOR SMALL OFFICES.

The Test Board shown in Fig. 3 consists of a framework divided into three sections, each of which is closed by a hinged door. On the front of each door are fixed screw terminals provided with long pins which project through to the back of the door. All line, apparatus and battery wires are soldered to the pins at the back of the doors. The terminals on the front of the door are left clear, so that by means of metal straps or short lengths of wire any desired connections may be made on the terminals without disturbing the permanent wiring made on the pins.

TEST-BOX FOR SMALL OFFICES. PRIMARY BATTERIES.

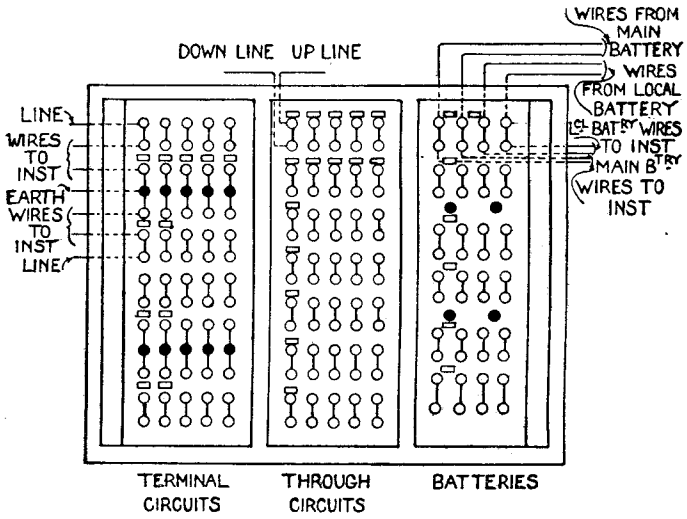

Fig. 3.

The left hand section is used for connecting lines to instruments on circuits terminating in the office. Four terminals, *Line, Inst, Inst, Earth,* are used for each terminating circuit. As the "earth" terminal is made "common" to two circuits, only seven terminals in a vertical row are required for each two circuits. The first, or top, terminal is known as an "up" line terminal and the seventh as a "down" line terminal. This practice is not strictly adhered to, the lines, whether "up" or "down," being connected to the upper or lower terminals as space permits. Conventionally, the "up" side of a line wire is that side which is going towards London, and the "down" side that side going away from London. In Fig. 3 the earth terminals are shown black. The brass terminals used for the earth

connections are coloured black, so that they may be more easily identified, all the other terminals being left bright.

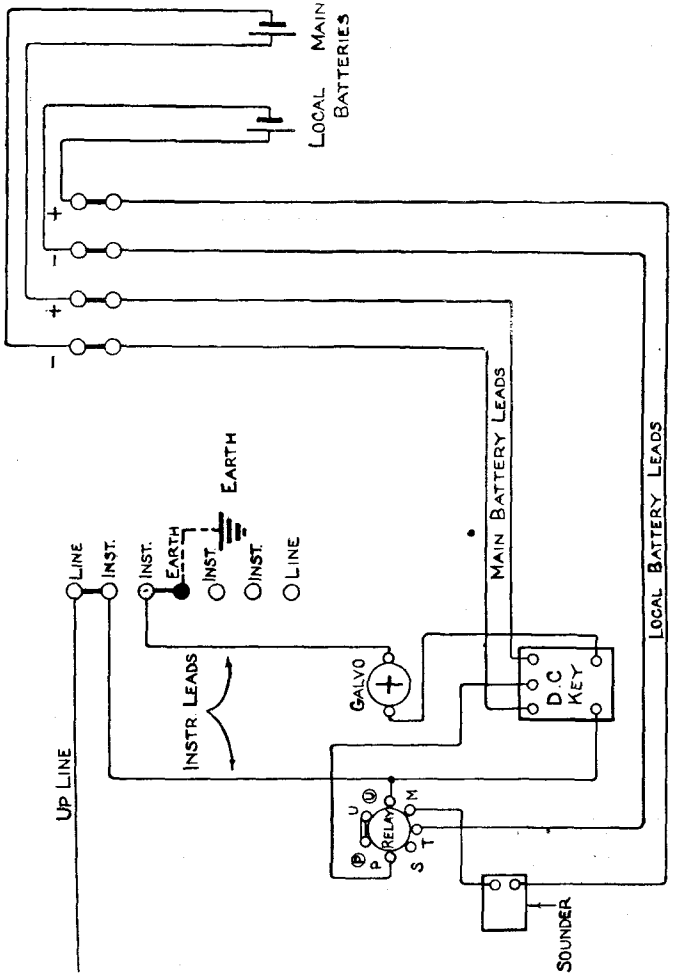

Fig. 4.

To the middle section are connected the lines forming the "through" circuits. On lines of any length it is usual to lead them on to, and out of, Test Boards fitted in offices on the route for the purpose of more expeditiously localising line faults

as they arise and affect the working of the circuits. Two terminals only are used for each line, the " up " side of the line being joined to the upper terminal and the " down " side to the lower terminal, a strap connecting the two terminals.

The right hand section is used for connecting the various sets of apparatus to their respective batteries. Four terminals are used for each separate battery.

The title of each circuit connected to the Test Board is engraved on a small label fitted close to the corresponding line and battery terminals.

Fig. 4 shows the Test Board arrangement for Double Current Sounder apparatus on a terminal circuit. On the left hand section of the Test Board the line is secured to the pin of the line terminal. This terminal is joined by a strap to the adjacent lower instrument terminal, which is connected to the apparatus

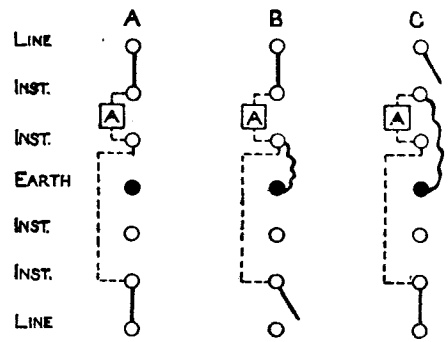

Fig. 5.

on the instrument table. The return wire from the instrument table is joined to the next lower instrument terminal, which in turn is joined to the earth terminal by a strap. A main and a local battery are required for D.C. Sounder working. The pair of wires from each battery is brought to adjacent horizontal terminals on the right hand section. Each of these terminals is strapped through to the terminals next below, wires being taken from these two lower terminals to the apparatus on the instrument table. On a Test Board the negative lead from the battery should always be brought to the left hand terminal of a pair of terminals, the positive lead being connected to the right hand terminal.

When more than two stations are on one circuit, every station other than the two terminal ones is known as an " intermediate " station. Test Board connections at an intermediate station are made as in Fig. 5A, the connection shown

in broken line being made permanently on the pins of terminals 3 and 6. Normally the earth return is not used on the circuit at an intermediate station. In the event of a fault on the "down" line affecting the working, any "intermediate" station can be rearranged as a terminal station and working maintained to the "up" station until the fault on the down line has been cleared. The change is made as follows:—

Remove the strap from terminals 6 and 7 and join terminal 3 to earth by a length of wire as in Fig. 5B. Similarly, if the "up" line is faulty, working can be maintained to the down station after removing the strap from terminals 1 and 2 and joining terminal 2 to earth as in Fig. 5C.

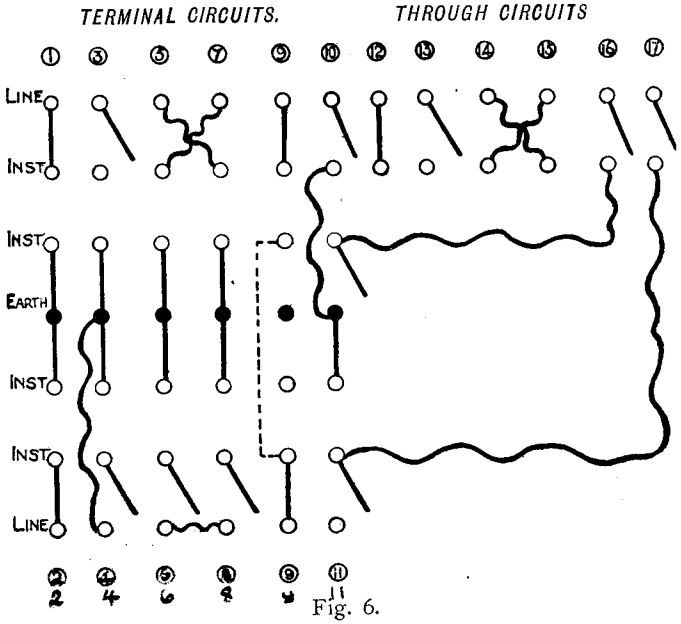

Fig. 6.

Fig. 6 shows some of the changes which may be required to be made on the front of the Test Board. The connections shown in waved lines are made by means of lengths of wire.

(a) The normal connections for a terminal circuit are as shown in 1 and 2.

(b) The normal connections for a "through" circuit are as shown in 12.

(c) The normal connections for an "intermediate" circuit are as in 9, the connection shown in broken line being made permanently on the pins of the terminals. (See also Fig. 5.)

(d) *To disconnect a line.* Remove line strap, as in 3 and 13.

(e) *To restore a line (or circuit).* Replace straps as for normal conditions.

(f) *To earth a line.* Remove line strap and connect the line terminal to an "earth" terminal, as in 4.

(g) *To change over (or cross) two terminal sets* of apparatus, make changes as in 5-7.

(h) *To loop two lines* or to "extend line *x* to line *y*." Remove line straps and join the named line terminals together as in 6-8.

(j) *To cross two "through" lines,* make changes as in 14-15.

(l) *To replace a faulty terminal line* with a spare section of a "through" line, remove line straps and join the replacing line to the apparatus as in 17-11.

(m) A temporary terminal circuit is required, the apparatus of line 10 and the down side of a "through" wire to be used. Normally, line 10 is joined to the "up" side of the apparatus. As the "down" side of the "through" wire is to be used, the "up" side of the apparatus must be put to earth, otherwise signals will be reversed. After removing the line straps, the changes to be made are as in 16-10.

There are other operations which may be required to be done, but the foregoing examples will be found to give the necessary guidance to the student.

TELEGRAPH TEST BOARD, 96 LINES, FOR PRIMARY BATTERIES.

The Test Board shown in Fig. 7 is designed to accommodate four panels fitted with test holes. The test holes in the two upper panels are arranged for line and instrument connections, the two lower panels being used for the battery connec-

TELEGRAPH TEST-BOARD. 96 LINES. PRIMARY BATTERIES.

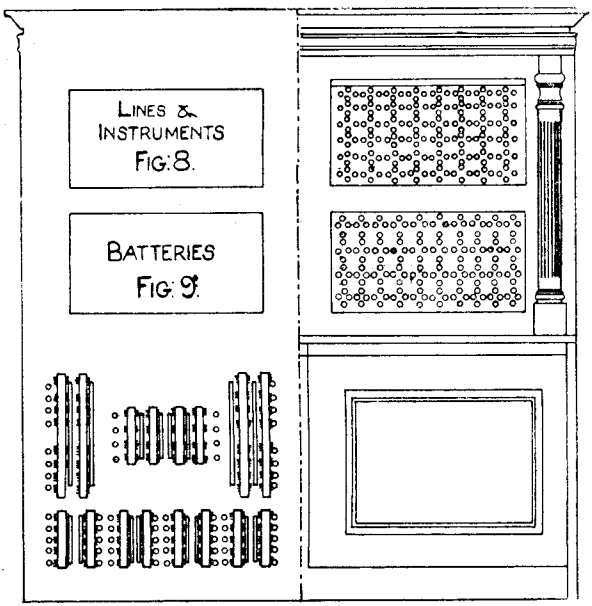

Fig. 7.

tions. The test holes in the line panels are arranged as shown in Fig. 8, and those in the battery panel as in Fig. 9.

The connections between the test holes in each group of four test holes are made by means of "U" links. Referring to Fig. 8; in the upper group of four test holes the line is connected

to the top test hole, the instrument leads to the two lower diagonal test holes and the earth return to the lower test hole. The upper group of four test holes is shown connected with " U " links for " up " line working. In the lower group of four test holes the line is connected to the lower test hole and the "U" links are inserted in the test holes for the "down" line working. To "earth" a line direct, the " U " links are inserted vertically into the line and earth test holes. Any changes which cannot be effected with U links are made by means of pairs of plugs connected by a single flexible conductor. On the battery

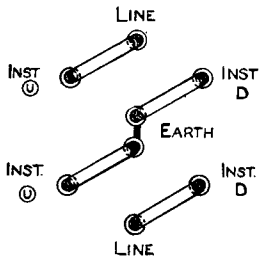

Fig. 8

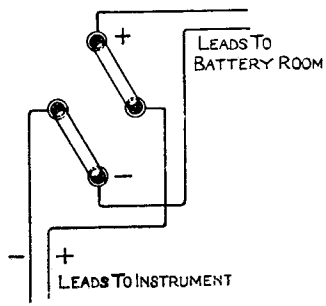

Fig. 9.

panel, Fig. 9, the positive lead of the battery is connected to the upper test hole of the group, the negative battery lead being connected to the lower test hole. The battery leads to the apparatus are connected to the two diagonal test holes of the group. Reference to Figs. 3 and 4 will show that the circuit arrangements of this board are similar in principle to those of the older pattern of Test Board, Fig. 3. The testing facilities are also similar.

A feature of this Test Board is the fitting of a "cross-connection field" in the lower half of the frame. As an improved cross-connection field has been adopted for the new standard pattern Test Board its use will be described when considering the standard Test Board.

TELEGRAPH TEST BOARD, 240 LINES, FOR SECONDARY CELL WORKING.

The Test Board shown in Fig. 10 accommodates four panels for line and instruments only. Each panel is fitted with test holes, two of which, placed vertically, are used for each circuit. The line is connected to the upper test hole, the instrument lead

TELEGRAPH TEST BOARD, 240 LINES, SECONDARY CELLS.

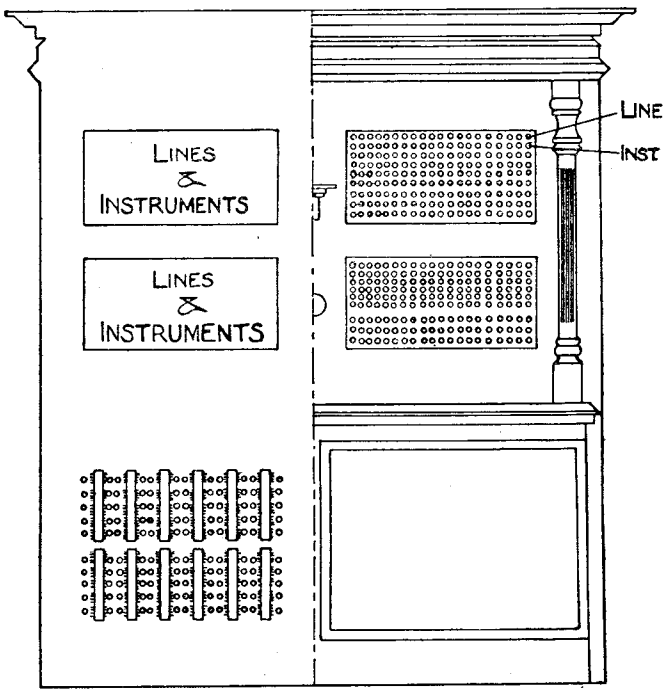

Fig. 10.

being connected to the bottom test hole, the insertion of a U link into the two test holes completing the connection. The arrangements for secondary cell working require only one lead from the Test Board to the instrument table. The line and instrument test holes are connected to strips of tags placed vertically in the lower portion of the frame, the connections between the test holes and tags being as shown in Fig. 11.

THE GENERAL CONDITIONS TO BE PROVIDED FOR ON A TEST BOARD AT A LARGE OFFICE.

Where a power plant is available, secondary cell working is adopted for telegraphic working instead of primary batteries. The use of secondary cells considerably modifies the wiring of a telegraph room. Fig. 12 shows diagrammatically the general wiring arrangements for terminal circuits at a large telegraph office.

It will be noticed that only one instrument lead is provided from the Test Board to the apparatus for each terminal circuit. On the instrument table this lead is first brought to a "connection strip, 7 tag," and then on to the apparatus. The

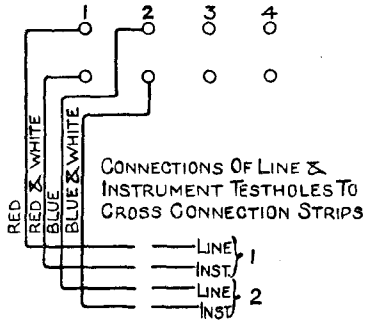

Fig. 11.

"earth return" for the apparatus is obtained on a "strip, earthing, 7 wire," on the outside of the back rail close under the projecting table top.

Each instrument table is similarly provided with "connection strips" and "strips, earthing." All the "strips, earthing," in the telegraph room are "commoned" to earth.

The positive and negative leads carrying the main and local currents from the secondary cells in the battery room are brought to the main distributing cabinet. The earth for the secondary cells is obtained in the battery room. From the main distributing cabinet, positive and negative leads are taken to a "distribution and fuse case" (cut-out No. 3 $\frac{80}{80}$ or No. 3 $\frac{100}{100}$) fitted at the end of the instrument table, suitable voltages being then taken to the apparatus fitted on the instrument table. Usually one distribution and fuse case is provided for each three instrument tables. With this arrangement of wiring, battery panels are not required on the Test Board.

The arrangement of the lines on a Test Board of a large office is important. The faults affecting lines are earths, dis-

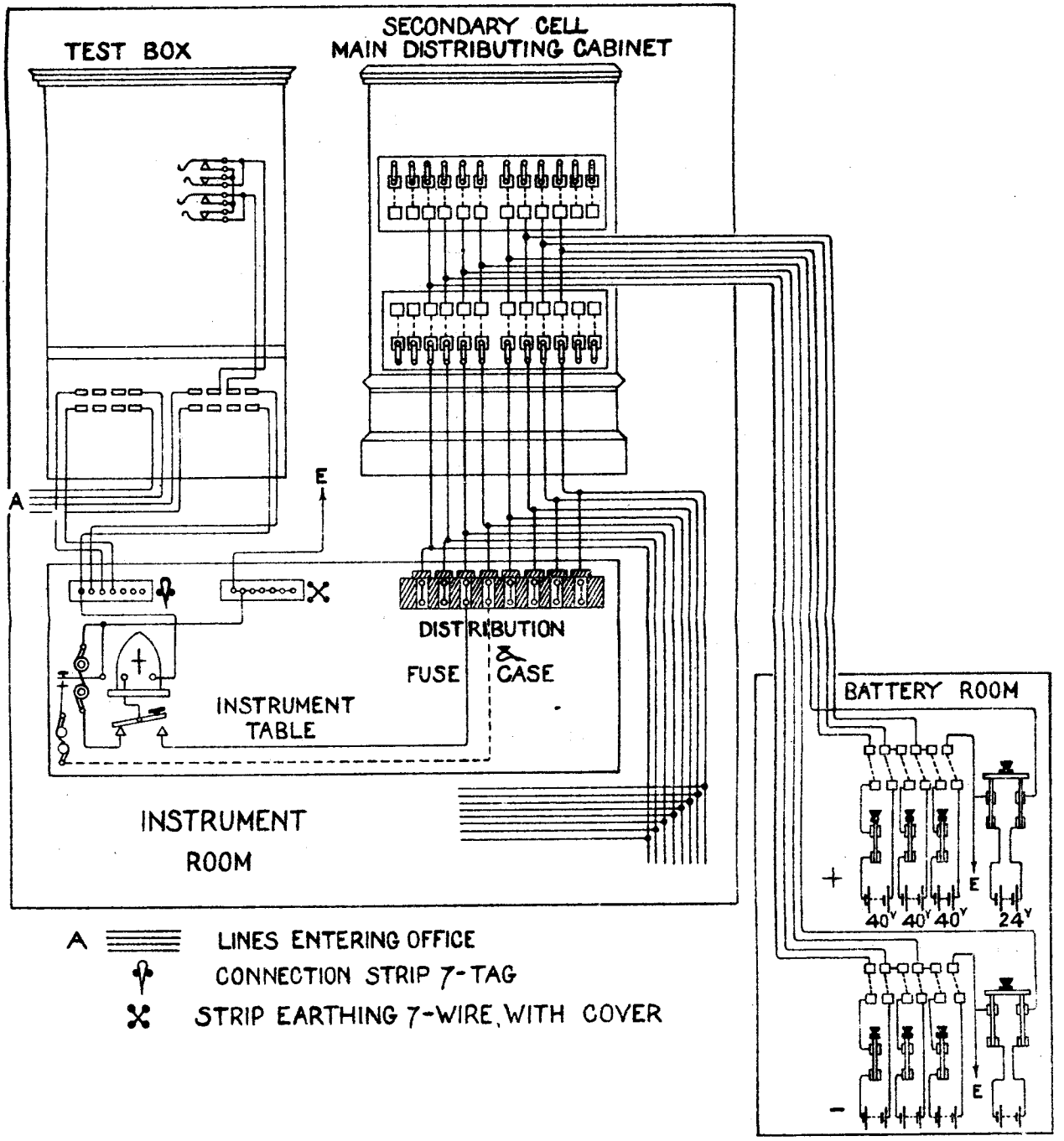

FIG. 12.

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connections and contacts. Each of these may be either full, partial or intermittent. An "earth" or a "disconnection" fault will affect only the one line. A "contact" fault will affect two or more lines on the same route. The possible "breakdown" of a route must never be lost sight of. To trace more expeditiously "contact" faults, the lines are brought on to the Test Board in the order of their routes. This order also enables observation to be kept over all the lines on any one route for faults affecting the general condition of the route.

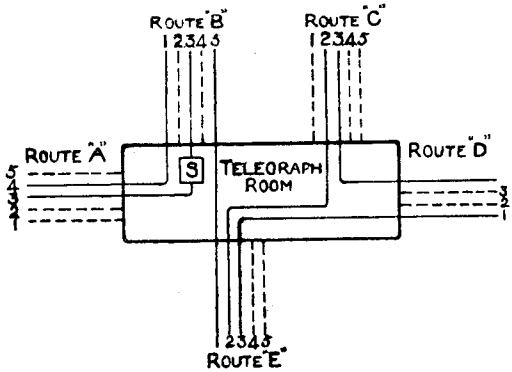

Fig. 13.

Fig. 13 has been drawn to represent a number of routes converging on an office. In the figure the terminal lines are shown in broken line, the "through" lines being shown in full line. On the Test Board the lines from Route A will be connected to one strip of test holes, those on Route B to another strip of test holes, and so on. Each "through" line will therefore appear twice on the Test Board, according to the incoming route and the outgoing route. Over each row of test holes is a label engraved with the name of the route, and over each line test hole is a small label engraved with the code title of the circuit.

TELEGRAPH TEST BOARD, STANDARD PATTERN, FOR SECONDARY CELL WORKING.

The standard pattern Test Board is arranged in panels each accommodating 120 lines on six line and instrument strips, 20 per strip. In place of test holes and U links, 5-point switch springs are used, the inner springs of the respective line and

TELEGRAPH TEST BOARD, STANDARD PATTERN, FOR SECONDARY CELLS.

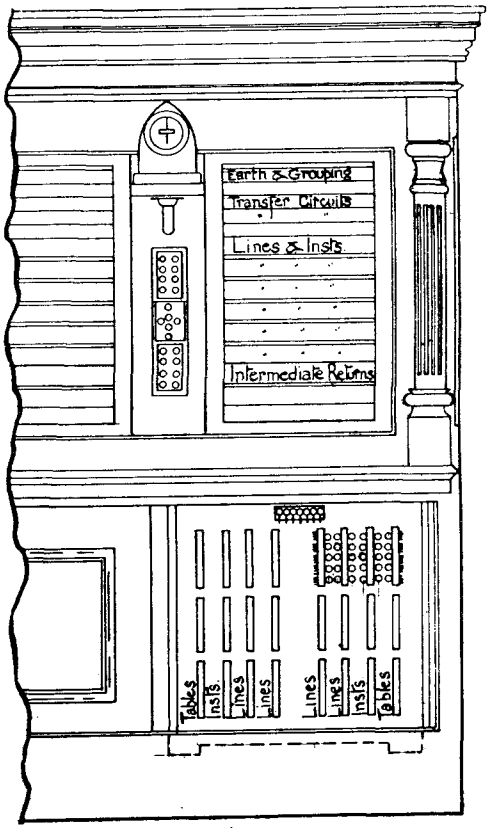

Fig. 14.

instrument switch springs being connected together. Fig. 14 is a front view of a two panel Test Board for 240 lines. In the lower half of each panel is a " cross-connection field " made up of 24 strips, cross-connection, 20-tag, placed vertically. The

nethod of joining up the lines and apparatus will be given with the aid of Fig. 15.

There are four strips, cross-connection, 20-tag, placed vertically, in the lower half of the frame for each strip of 20 line and nstrument test holes in the upper panel. The lines are brought o the first vertical strip of line tags in the selected order of the outes. The tags of the second line strip are connected to the

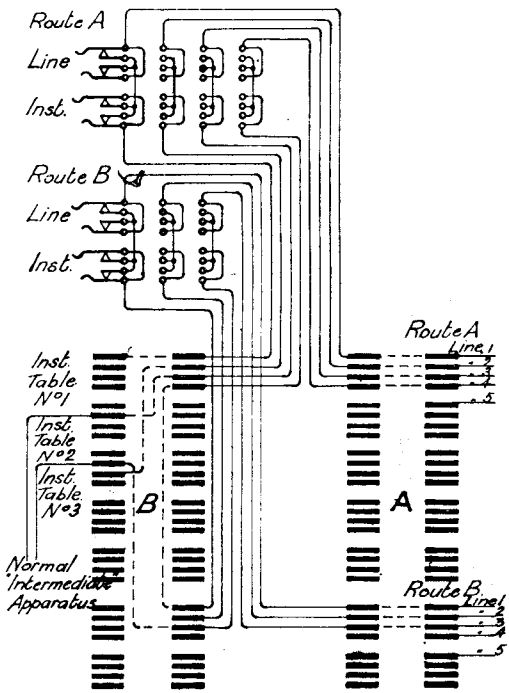

Fig. 15.

ine test holes, and the corresponding instrument test holes are connected to the strip of instrument tags. The fourth row of ags is connected to the connection strip, 7-tag, on the instrument table by a 5-wire (or a 7-wire) cable. Let a 5-wire cable rom the connection strip on No. 1 instrument table be connected to the table tags 1-5. Similarly let No. 2 instrument able be connected to table tags 6-10, and so on. There are now wo points *A* and *B* on the "cross-connection field" which are ıot connected. Referring to Fig. 13, let it be intended to con-

nect Route *A* to line and instrument strip No. 6, the apparatus for the terminal line 1 being fitted on the No. 1 instrument table. To do this the points *A* and *B* will require to be "bridged" by short lengths of wire as shown in broken line in the figure. Now take terminal line 2 of Route *A* and let the apparatus for this circuit be fitted on No. 3 instrument table. To complete the connection for this circuit the point *A* must be "bridged" to bring in the line and instrument test holes, and the instrument tag of test hole 2 be "jumpered" to one of the tags of No. 3 instrument table as shown. A "through" line appears on two line and instrument strips. In Fig. 13, line 4 of Route *A* is shown as going out as line 1 of Route *B* on line and instrument strip 4. In this case, after the points *A* of both line 4 of Route *A* and of line 1 of Route *B* have been "bridged," the corresponding instrument tags of these lines are connected together by a "jumper" as shown in the figure. In Fig. 13, line 3 of Route *A* represents a normal "intermediate" circuit going out on line 3 of Route *B*. Let the apparatus *S* be fitted on No. 2 Instrument Table. After "bridging" the points *A* of line 3 Route *A* and of line 3 Route *B* respectively, the instrument tag of line 3 Route *A* is connected to No. 2 instrument table. For the return wire from the apparatus a spare wire is taken up in the cable between the connection strip on No. 2 instrument table and the table tags, say, tag 5, and when this tag has been "jumpered" to instrument tag 3 of line 3 Route *B*, the Test Board connections will be complete, as in Fig. 15. For the full connections of the normal "intermediate" apparatus see Telegraph Diagram Book, Plate 53.

It will be seen that all the wiring changes which may be necessary to meet the requirements of the telegraph room from time to time can be effected at the points *A* and *B* without disturbing the cable wiring of the office.

Test Board Changes.—The changes on the front of the Test Board are made by means of pairs of solid plugs connected by a flexible single conductor. The insertion of a plug in the line test hole opens the switch springs, cutting off the instrument side. Similarly, if the plug is inserted in the instrument test hole, the line is cut off.

It will be apparent that "crosses" of lines and of instruments can be readily effected with a pair of plugs and cords, the plugs being inserted into the respective switch springs of the lines and instruments to be "crossed." To disconnect a line, a single plug without conductor is inserted in the line test hole. To "earth" a line, a pair of plugs with flexible conductor is used, one plug being inserted in the line test hole, the other plug of the pair being inserted in one of the "earth" test holes on the *earth and grouping strip*.

Earth and Grouping Strip.—Six of the test holes on this strip (Fig. 16) are used for making "earth" connections on the Test Board as may be needed. The remaining test holes in the strip are made up of two groups of three test holes and

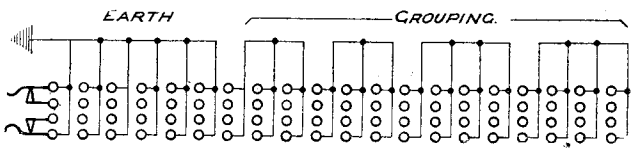

Fig. 16.

two groups of four test holes. These groups are used for special arrangements of "forked" circuits, the test holes of the lines and instruments to be used being connected to a suitable group by pairs of plugs and cords.

Transfer Circuits (Fig. 17).—When two or more panels are provided, transfer circuits between panels are made use of to avoid the use of long flexible conductors. To connect a line

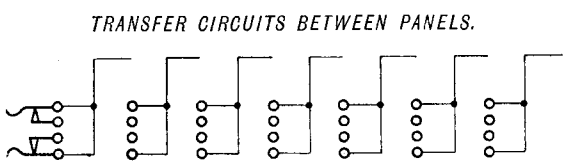

Fig. 17.

on panel 1 to a line on, say, panel 4, two pairs of plugs and cords would be used, one plug of each pair being inserted into the respective line test holes, the other plug of each pair being inserted into a suitable transfer circuit.

"Intermediate Returns" Strip.—It has been previously mentioned that with secondary cells the "earth return" for terminal circuits is obtained on a "strip, earthing, 7-wire," fitted on the instrument table. This wiring tends to limit the use of the fitted apparatus when required for emergency or special arrangements. To overcome this difficulty the "earth return" for a number of sets of apparatus is obtained by using switch springs on the "intermediate returns" strip of the Test Board, instead of on the "strip, earthing," at the instru-

ment table. In Fig. 18 is shown the principle of wiring a telegraph set so that it may be available either for a terminal circuit or for an intermediate circuit. These special sets are provided with reversing switches for changing to "up" or "down" working as required. The additional wiring shows two leads run from the apparatus to the selected test hole on the "intermediate returns" strip. The lead from (U) of the relay makes "earth" through one of the inner springs of the test hole. In the lead from the left hand front terminal of the

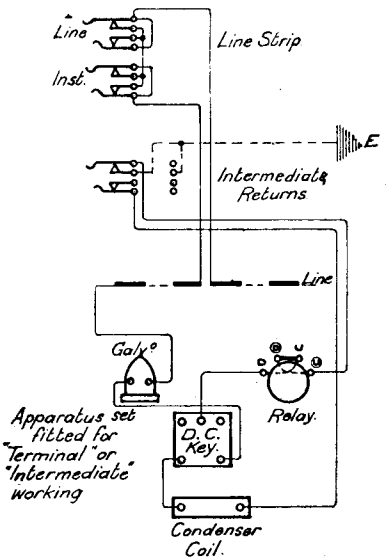

Fig. 18.

D.C. key is an adjustable resistance. For terminal circuit working this resistance is not needed. When the apparatus is required for an "intermediate" circuit, the line having the higher resistance is connected to the instrument test hole on the line and instrument strip, the line having the lower resistance being connected to the test hole on the "intermediate returns" strip. To balance the outgoing currents, suitable resistance is unplugged in the adjustable resistance. It should be noticed that this adjustable resistance is in the sending current circuit only, and that the received current is not affected by it. Also that the plug, when inserted in the "inter-

mediate returns" test hole, makes the necessary connection between the two outer switch springs, at the same time cutting off the "earthed" inner spring. For full connections of the special sets, see the Telegraph Diagram Book, Plates 66 and 67.

TRUNK TEST BOARDS.

Trunk and junction speaking circuits make use of a return line wire, not of an "earth return," as in the case of telegraph circuits. Both line wires of each trunk and junction circuit must be accommodated on the Trunk Test Board. To distinguish the line wires of the pair of wires forming the metallic loop, one of the line wires is known as the "A" line, the other line wire of the pair being known as the "B" line.

As in the case of telegraph test boards, a series of tag connection strips is provided in the lower portion of Trunk Test Boards. The use of the cross-connection field on Telegraph Test Boards has been explained in detail. The same principle operates in the case of trunks and junctions, and it is now only needful to point out that tag and jumper connections are provided for each wire of the pair of wires forming the trunk or junction circuit.

Trunk Test Boards for Small Offices.—At the smaller offices the type of Trunk Test Board provided is that known as—

Case, Test, D 1930 $\frac{10}{20}$

or Case, Test, D 1930 $\frac{20}{40}$.

The **Case, Test, D 1930** $\frac{10}{20}$ may be fitted with two strips of test holes to accommodate a total of 20 trunks or junctions, 10 per strip. Fig. 19 shows the wiring for a terminating trunk or

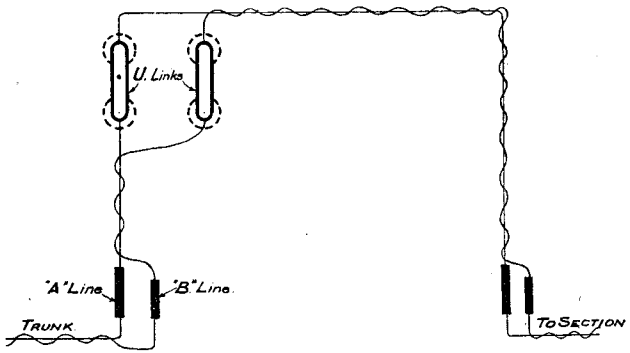

Fig. 19.

junction. The " A " and " B " line wires of a terminating trunk or junction are connected to the lower left-hand and right-hand test holes respectively, the corresponding connections to the switch sections being made on the two upper test holes.

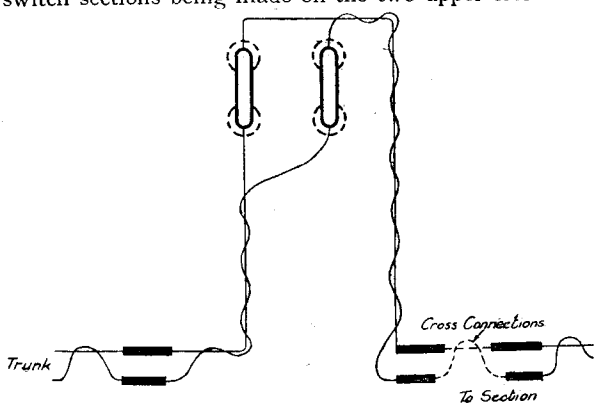

Fig. 20.

The **Case, Test, D 1930** $\frac{20}{40}$ is fitted with two strips of test holes for a total of 20 terminating trunks. Also with one strip of test holes for 10 " through " or " miscellaneous " circuits, and one strip of test holes which may be used either for batteries or for miscellaneous circuits. Fig. 20 shows the wiring of the first two strips for terminating trunks or junctions.

Fig. 21 shows the wiring of a " through " trunk on the third strip of test holes. The wires proceeding to the " up " office are connected to the two top terminals, the wires to the " down " office being connected to the two bottom terminals.

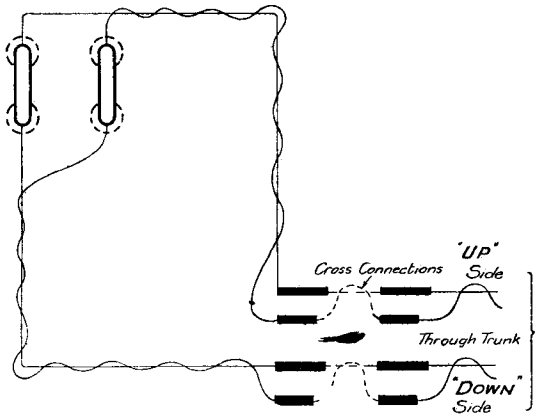

Fig. 21.

Fig. 22 shows the wiring for a battery on the fourth strip of test holes. This wiring precludes the short-circuiting of the battery by the incorrect insertion of a U link. If required, this strip of test holes may also be used for miscellaneous circuits.

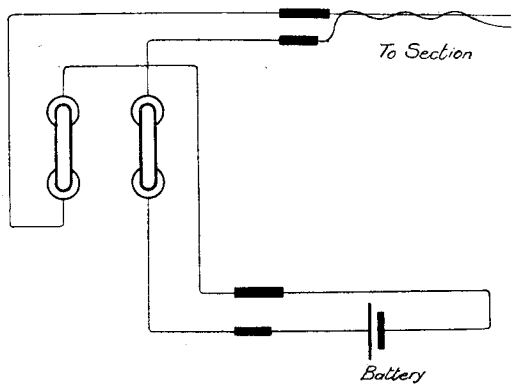

FIG. 22.

On the top of the test case two test holes are provided which may be used either for connecting a Test Telephone to the lines or a Detector No. 2 for line or battery testing, the connections between the telephone test holes and line test holes being made by means of pairs of single conductor plugs and cords.

At the left-hand side of each strip of test holes is a single test hole connected to "earth."

Technical Pamphlets for Workmen.

Amendments January, 1928.

P.W.-A.4.

Page 8. *Fig* 6. *Figures in circles at foot should read* "2, 4, 6, 8, 9, 11." 1/28

Pages 21, 22 *and* 23. *Amendment of* 1/24. "Owing to the cancellation of Fig. 22 advance Nos. of all figures by 1, commencing with Fig. 23 and relative references in text to the end of the pamphlet (*e.g.*, Fig. 23 becomes Fig. 22, etc.)." 1/28

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plugs and cords are used.

Trunk Test Boards for Large Offices:—*Trunk Test Boards fitted with Test Holes.*—The design of the framework of the Trunk Test Board fitted with test holes follows broadly that of Figs. 7 and 10. Two or more panels may be fitted, each panel

accommodating 40 trunk or junction circuits. Fig. 24 shows the wiring of the test holes and tags. The line and testing changes made on the front of this Trunk Test Board are similar to those shown in Fig. 23.

WIRING OF CROSS CONNECTION STRIPS AND TEST HOLES.

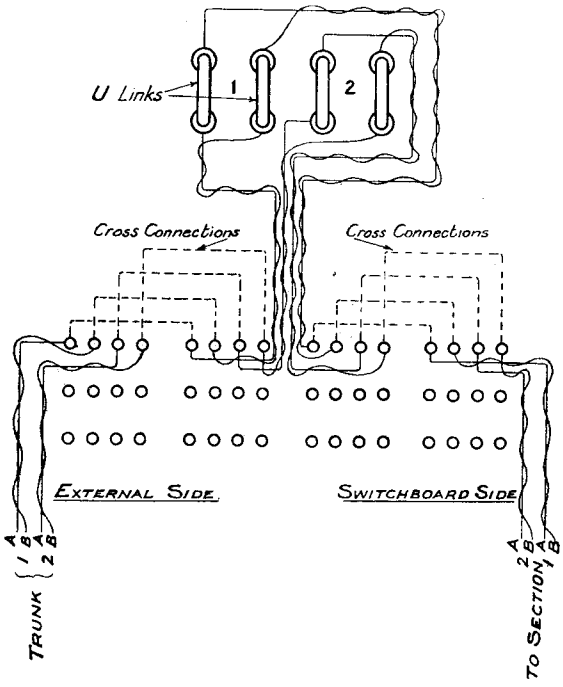

Fig. 24.

Trunk Test Board Fitted with Switch Springs.—The general design of the Trunk Test Board fitted with 5-point switch springs is similar to that shown in Fig. 14, the essential difference being in the wiring of the switch springs. As shown in Fig. 25, the " A " and " B " line wires of the trunk or junction circuit are connected to the short and long outer springs respectively of the line switch spring. The connections to the switch section are similarly made on the instrument switch springs, the inner springs of both the line and instrument switch springs being separately wired.

In order that each wire of the pair of wires connected to any of the outer switch springs may be brought individually under test when required, a specially wired series of test switch springs is fitted on the Trunk Test Board and connected to either a "Test Tablet" or to a "Test Desk." The connection between

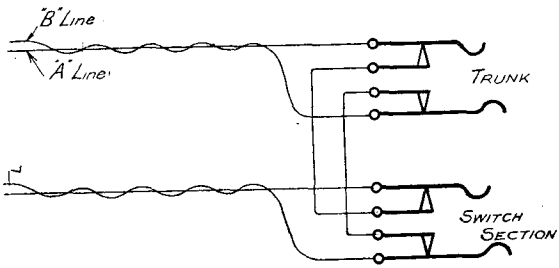

Fig. 25.

the faulty loop and the special test switch springs is made by means of 2-conductor plugs and cords. Provision is also made for connecting a Test Telephone set to any circuit.

Transfer circuits between panels are also provided.

SUPERPOSED TELEPHONE CIRCUITS.

Where two identical telephone loops exist between two offices, a third or "plus" (+) circuit may be obtained by means of repeating coils fitted at each end of both loops. The arrangement is shown diagrammatically in Fig. 26, where *P* and *S* are

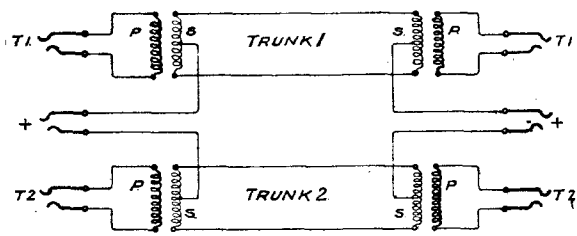

Fig. 26.

respectively the primary and secondary windings of the repeating coils. The secondary is made up of two equal windings, the connection for the "plus" circuit being made at the junction of the two windings.

Whilst any faults which tend to unbalance this arrangement will disturb the working of the "plus" circuit, it may still be possible to work the two metallic loops satisfactorily if the repeating coils are removed. "Night" and "Sunday"

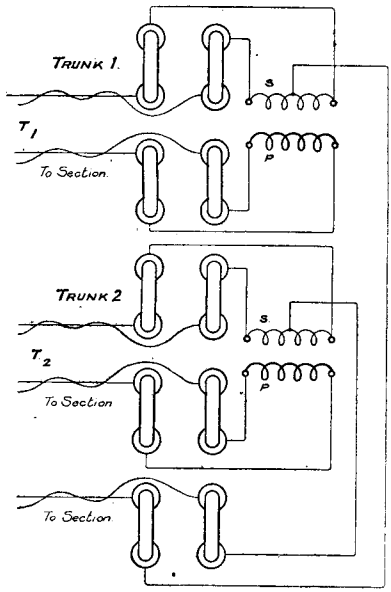

FIG. 27.

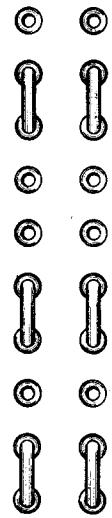

FIG. 28

arrangements may also necessitate the removal of the repeating coils. The normal connections for readily effecting these changes on a Trunk Test Board fitted with test holes and U links are shown in Fig. 27.

To remove the repeating coils, rearrange the U links as shown in Fig. 28.

The wiring connections on a Trunk Test Board fitted with 5-point switch springs are shown in Fig. 29. The lines are first brought to the line and instrument strips to maintain the "route" system, and then carried on to the miscellaneous circuits strip.

Any circuit changes which may be required on the front of the Test Board can be effected by means of two-conductor

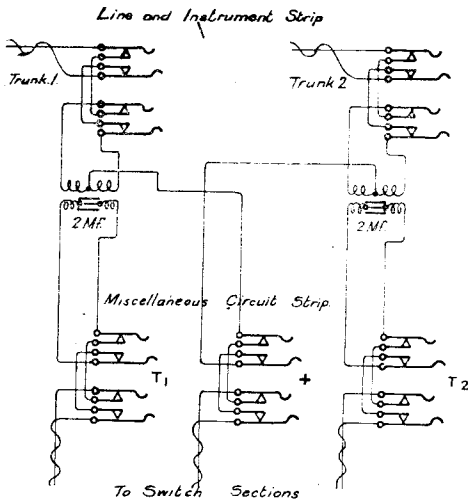

Fig. 29.

plugs and cord. The 2 m.f. condenser shown inserted between the two equal windings of the primary is provided to avoid making changes on the switch section cords fitted for auto-signalling.

SUPERPOSED TELEGRAPH CIRCUITS.

A telegraph circuit may be superposed on a telephone loop by means of repeating coils. The repeating coils are wired to

the Trunk Test Board, the superposed telegraph circuit being carried on to the Telegraph Test Board as in Fig. 30.

If the trunk normally fitted with this arrangement is interrupted by a fault, the apparatus can be transferred to a good trunk by means of two-conductor plugs and cord inserted in the corresponding line and instrument switch springs on the Trunk Test Board.

TRUNK TEST BOARD.

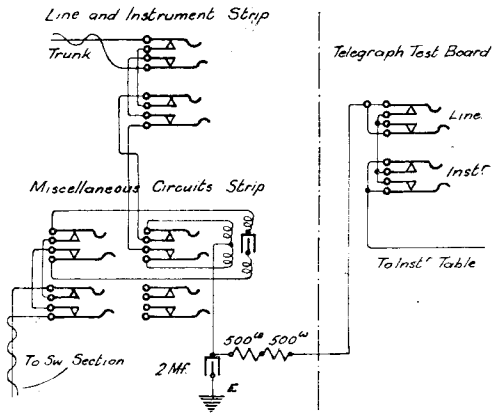

Fig. 30.

TEST ARRANGEMENTS FOR THE LOCALISATION OF FAULTS.

Many faults affecting both telephone and telegraph circuits commence as slight defects, which gradually develop until the circuit is definitely interrupted. The early localisation of these faults may require precise electrical measurements by means of the Wheatstone Bridge, Megger or other sensitive testing device. A large number of faults, however, do not require actual electrical measurement and may be localised between testing points by simple operations involving only the use of a battery, galvanometer and tablet switch. There are modifications in the wiring of the tablet switches according to the con-

ditions obtaining in a particular office. Fig. 31 shows the principle of the wiring of a Tablet, Test, 7-hole, with battery, galvanometer and earth connections, the wiring shown being made permanently at the back of the tablet switch and galvanometer.

Fig. 32 shows changes which may be made on the front of the tablet switch by means of U links, the waved lines repre-

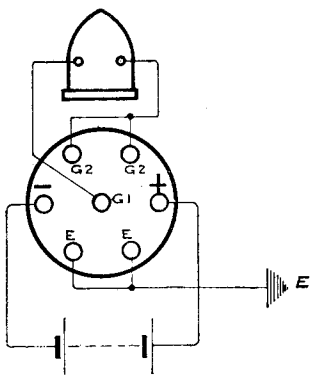

Fig. 31.

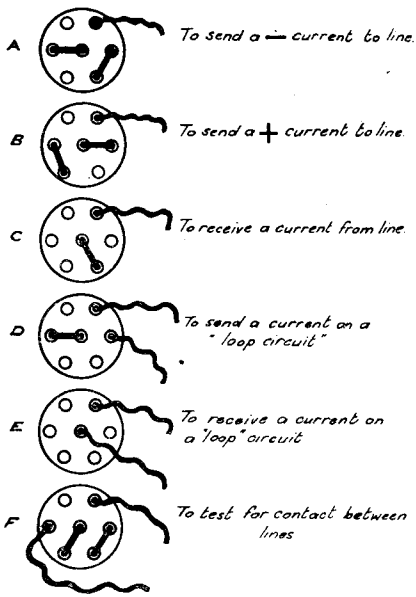

Fig. 32.

senting pairs of solid plugs with single flexible conductors used for making connection between the tablet switch and the line or lines under test. The arrangement shown in Fig. 31 is sometimes modified to suit special cases.

Simple Test for an "Earth" Fault.—The effect of an "earth" fault is to increase the amount of current normally sent out at the sending station and to decrease the amount of current normally received at the receiving station. Proceed to localise as follows:—Ask the distant station *C* to disconnect the faulty

line wire at the Test Board, and arrange the tablet switch as in *A* of Fig. 32, connecting *G2* to the faulty line. The testing arrangements will now be as in Fig. 33.

Suppose *f* to be the earth fault and *A* and *B* to be intermediate offices into which the line is led for testing. Station *C* having disconnected the line wire as instructed, a deflection of the needle will be observed on the testing galvanometer. Ask station *B* to *disconnect* the faulty line wire. When this is done, the galvanometer needle will return to zero, showing the line to be clear to that point. On restoring the line at station *B*,

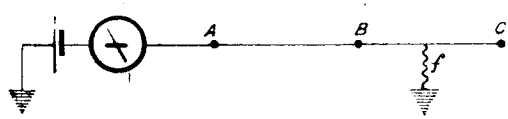

Fig 33.

the galvanometer will again be deflected, proving the fault to exist between stations *B* and *C*.

Simple Test for a Disconnection on a Single Line Wire.—The effect of this fault is that a current does not leave the sending station, owing to the normal return path of the current being interrupted. To localise this fault, a temporary earth return path is put on the line at the intermediate testing offices as instructed by the controlling office. Proceed as follows :— Again arrange the tablet switch as in *A* of Fig. 31, connecting

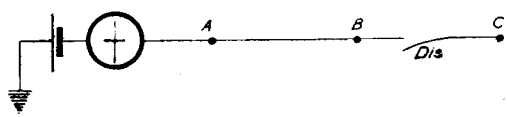

Fig. 34.

G2 to the faulty line wire. The testing arrangements will be as in Fig. 34.

Station *C* is instructed to earth the line wire. The galvanometer needle will not show a deflection. Station *B* having been instructed to earth the line wire, a deflection of the galvanometer needle will be observed, proving the line wire to be in order to that point. On taking off the temporary earth connection and restoring the line at station *B*, the galvanometer needle again shows no deflection, proving the disconnection fault to exist between stations *B* and *C*.

Simple Test for an " Earth " or a " Disconnection " Fault on a Loop Circuit.—To localise an " earth " fault on a loop circuit, both the " A " and " B " line wires are disconnected at the ter

minal testing office, the two wires being then individually tested as for single wires.

A " disconnection " fault on a loop circuit may be localised by proceeding as for single wires. The more usual method of localisation is that in which the " A " and " B " line wires are looped at the intermediate testing offices. Proceed as follows :— Instruct station *C* to "loop" the two line wires, and arrange the tablet switch as in *F* of Fig. 31, connecting *G*2 and negative (—) to the two line wires of the loop under test. The testing arrangements will now be as in Fig. 35.

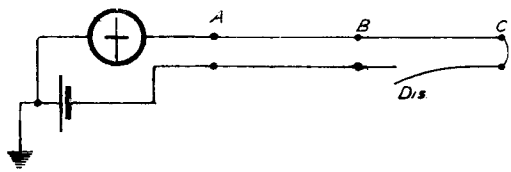

Fig. 35.

Station *C* having looped the two line wires, as shown in the figure, no deflection of the galvanometer needle will be observed.

Station *B* is then asked to loop the two line wires, and when this has been done the galvanometer needle will be deflected, showing the loop to be good to that point and that the disconnection fault exists between stations *B* and *C*.

It will be noticed in this test, as also in that for " contact," that an earth connection is made between the galvanometer and battery. If this earth connection is omitted, an earth fault on both wires of the loop will cause a deflection of the galvanometer needle, so giving a false testing result.

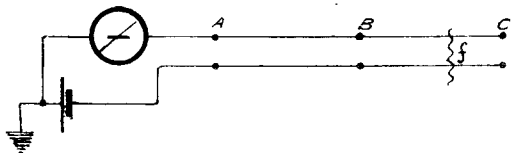

Fig. 36.

Simple Test for Contact Between Two Line Wires.—The effect of this fault on single line circuits is that a current sent out on one circuit is received on another circuit. In the case of a loop circuit, the effect is to short-circuit the current sent out, little or no current reaching the distant end of the loop circuit. Instruct station *C* to disconnect the line wires. Arrange the tablet switch as in *F* of Fig. 31 and connect *G*2 and negative (—) to the two faulty line wires. The testing arrangements will be as in Fig. 36.

Suppose *f* to be the contact fault. When station *C* has disconnected the line wires, a deflection of the galvanometer needle is observed, showing the fault to exist between the testing office and station *C*. Station *B* is then instructed to disconnect the line wires. When this has been done, the galvanometer needle will not be deflected. The contact fault therefore exists between stations *B* and *C*.

To Receive a Current from a Single Line.—The tablet switch is arranged as in *C* of Fig. 32, *G2* being connected to the line wire on which the current is to be received. With this arrangement, if the received current is positive, the galvanometer needle will be deflected to the left of zero. If a negative current is being received, the galvanometer needle will be deflected to the right of zero.

To Send or Receive a Current on a Loop Circuit.—The tablet switch connections are arranged as in *D* and *E* respectively of Fig. 32.

For tests made with the Wheatstone Bridge and Megger, see Pamphlet A6, Measuring and Testing Instruments.

In the foregoing tests much time will be saved in localising if, after having proved that the fault is not in the apparatus at the terminal station, the next test be made to a point midway along the line. If clear to that point, then the next test should be made to some point about midway along the remaining section; and so on, always halving the distance until the fault is eventually located between two consecutive offices. Thus

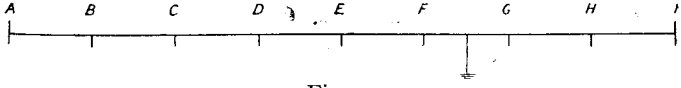

Fig. 37.

Suppose an earth fault to exist between *F* and *G*. Then *A* (the testing office) after having proved that the fault is not in the apparatus at *I*, should instruct *E* to disconnect. Finding it clear to that point he will next instruct *G* to disconnect. He will now find that the fault is between *G* and *E*. Finally he will ask *F* to disconnect and thus definitely locate the fault between the two consecutive stations *F* and *G*.

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