FOR OFFICIAL USE

G 4

PW—G 4

Post Office Engineering Department

TECHNICAL PAMPHLETS FOR WORKMEN

Subject

Telegraph Battery Power Distribution Boards

(*Reprinted March,* 1932, *including Correction Slips to date.*)

ENGINEER-IN-CHIEF'S OFFICE
1919

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Technical Pamphlets for Workmen

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2. Primary Batteries.
3. Technical Terms.
4. Test Boards.
5. Protective Fittings.
6. Measuring and Testing Instruments.
7. Sensitivity of Apparatus.
8. Terms and Definitions used in Telegraphy and Telephony (not on sale).

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1. Elementary Principles of Telegraphy and Systems up to Morse Duplex.
2. Telegraph Concentrators.
3. Wheatstone. Morse Keyboard Perforators.
4. Quadruplex. Telegraph Repeaters, Sx., Dx., and Quad.
5. Hughes Type-printing Telegraph.
6. Baudot Multiplex.
7. Western Electric Multiplex. Murray Multiplex. Other Systems.
8. Fire Alarm Systems.

GROUP C.

1. Wireless Transmission and Reception.
2. Interference with reception of broadcasting.

GROUP D.

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3. Principles of Telephone Exchange Signalling.
4. Magneto Exchanges—Non-Multiple Type.
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6. C.B.S. No. 1 Exchanges—Non-Multiple Type.
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8. C.B. Exchanges—No. 9 Type.
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15. Telephone Testing Equipment.
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17. Internal Cabling and Wiring.
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Continued on page iii of Cover.

FOR OFFICIAL USE

TELEGRAPH BATTERY POWER DISTRIBUTION BOARDS

(G.4.)

The following pamphlets are of kindred interest :

G.1. Secondary Cells, Maintenance of.

G.2. Power Plant for Telegraph and Telephone Purposes.

G.3. Maintenance of Power Plant for Telegraph and Telephone Purposes.

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CORRECTION SLIP TABLE.

The month and year of issue is printed at the end of each amendment in the Correction Slips, and the number of the slip in which any particular amendment is issued can, therefore, be traced from the date. In the case of short corrections made in manuscript, the date of issue of the slip should be noted against the correction.

The Summary portions of the Correction Slips should be completed and affixed below in numerical order.

CORRECTION SLIP TABLE—(Contd.).

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The Summary portions of the Correction Slips should be completed and affixed below in numerical order.

TELEGRAPH BATTERY POWER DISTRIBUTION BOARDS

The most simple case of Secondary Cell Power Distribution is that in which the whole installation of cells is charged as one battery and discharged in the same way through a single external circuit.

In such a case the whole of the switching requirements, so far as the cells are concerned, are covered by one double pole two-way switch, which connects the battery alternately to the charging and discharging circuits (see Fig. 1).

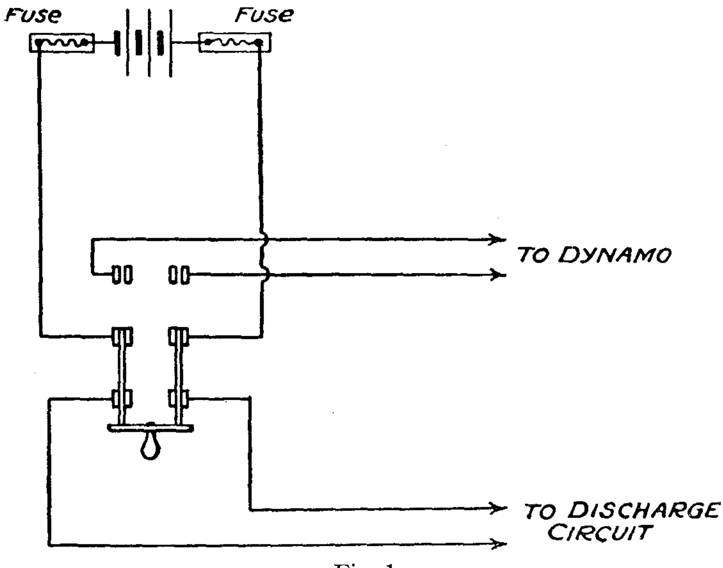


Fig. 1.

The distribution of power from a Secondary Cell Installation **to a Telegraph Instrument Room** is a much more complex matter, and the conditions to be fulfilled necessitate the use of various units which together form a comprehensive switching, testing, and protective system.

These conditions are :—

(1) That the cells shall be adequately protected against leakage and excessive discharge currents.

(2) That various voltages may be available for varying power requirements.

(3) That the voltage on any circuit may be readily increased or decreased to meet working conditions.

(4) That, as far as possible, no one cell shall be more heavily worked than any other in the battery.

(5) That charging shall be possible without wasteful provision of spare battery power.

(6) That the charging machine may be connected readily to the various sections of the battery for charging purposes.

(7) That the wiring between the battery and the instruments shall be as economical, both as regards space occupied and cost of material, as is consistent with efficiency.

A complete Installation comprises:—

(*a*) The charging machine with its switching equipment and wiring to the Secondary Cell Switch Cabinet.

(*b*) The Battery.

(*c*) Battery Fuses.

(*d*) The wiring between the Battery and the Secondary Cell Switch Cabinet.

(*e*) The Secondary Cell Switch Cabinet.

(*f*) The wiring between the Secondary Cell Switch Cabinet and the Secondary Cell Main Distribution Cabinet in the Instrument Room.

(*g*) The Secondary Cell Main Distribution Cabinet.

(*h*) The wiring between the Secondary Cell Main Distribution Cabinet and the Cut-outs, No. 3 on the Instrument Room Tables.

(*i*) The Cut-outs, No. 3.

(*j*) The wiring between the Cut-outs and the Instruments.

(*k*) Metal Cased Resistances or Resistance Lamps at the Instruments.

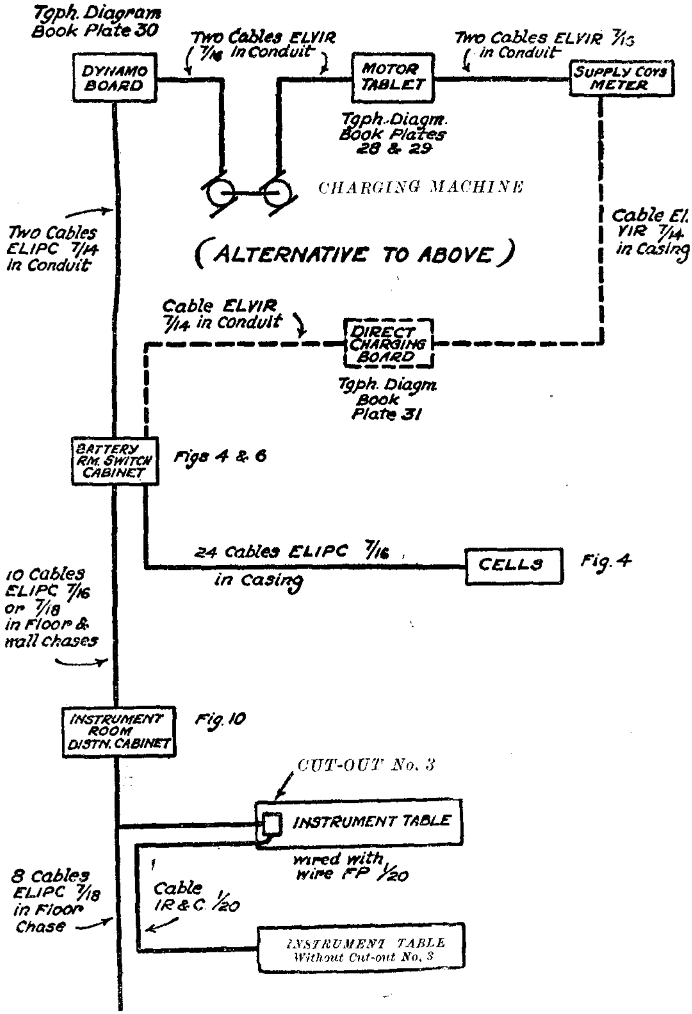
Fig. 2 shows in skeleton form the arrangement of equipment and wiring from the cells to the Instrument tables.

Charging Machines of various types, with their switching equipment and safety devices, are described in Pamphlet G.2.

THE BATTERY.

A complete installation of Secondary Cells for general purposes in a large Telegraph Office comprises 208 cells divided into eight units of 20 cells each and four units of 12 cells each. In some cases two spare cells have been provided, and these are usually placed in series with one of the local batteries.

The eight sets of 20 cells each provide voltages for the negative and positive mains of 40, 80 and 120 volts to serve all


Tgph. Diagram Book Plate 30
DYNAMO BOARD
Two Cables ELVIR 7/16 in Conduit
MOTOR TABLET
Two Cables ELVIR 7/15 in Conduit
SUPPLY COYS METER
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(ALTERNATIVE TO ABOVE)
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Figs 4 & 6
24 Cables ELIPC 7/16 in casing
CELLS
Fig. 4
10 Cables ELIPC 7/16 or 7/18 in Floor & wall chases
INSTRUMENT ROOM DISTN. CABINET
Fig. 10
CUT-OUT No. 3
INSTRUMENT TABLE
wired with wire FP 1/20
Cable IR & C 1/20
8 Cables ELIPC 7/18 in Floor Chase
INSTRUMENT TABLE Without Cut-out No. 3

Fig. 2.

circuits requiring 40 volts and over, two units of 20 cells each being always out of use for charging purposes.

The four units of 12 cells each provide power for local circuits and for short lines requiring not more than 24 volts.

They are arranged in such a manner that two sets, one on the negative and one on the positive side, are working while the other two sets are out of use and available for charging.

Diagrammatically the system may be represented as in Fig.3.

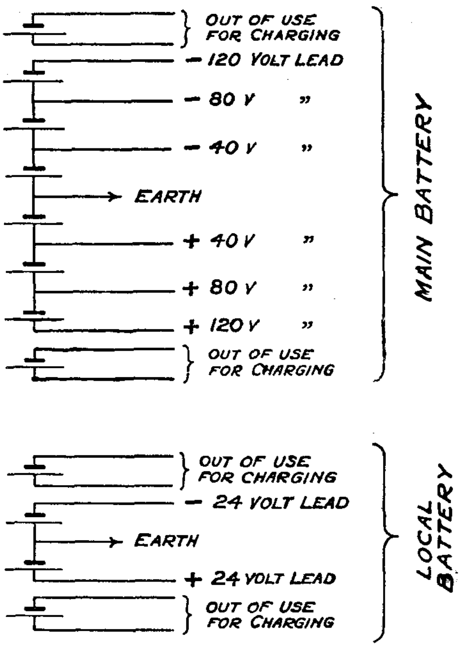


Fig. 3.

This arrangement fulfils condition (5), since only 64 cells or 44·4 per cent. in excess of working requirements are necessary.

The size of the plates in the cell, which gives their ampère-hour capacity, or, in other words, the amount of energy they are capable of storing, is determined by the number of circuits they are required to work.

The calculation required to ascertain the capacity necessary is a simple one.

It should be borne in mind that this method of calculation is only applicable to rotary switch installations in which each charging group, after charge, is passed in succession from the most heavily to the less heavily worked positions. The method of calculation for installations in which the positions of the groups are not changed is given on page 21.

Thus let it be assumed that the main battery in an imaginary office is required to serve :—

4 Quad. sets, each taking 50 milliampères and working 12 hrs. per day.

10 D.C.S.X. sets, each taking 30 milliampères and working 10 hrs. per day.

8 D.C. sets, each taking 30 milliampères and working 8 hrs. per day.

4 S.N.S. sets, each taking 20 milliampères and working 8 hrs. per day.

The first two classes of circuit will take current during the whole time, but the D.C. circuits and the Single Needles will take current during half that time only, since no current is being used when receiving. Therefore the actual working time for the present calculation may be taken as half the total time.

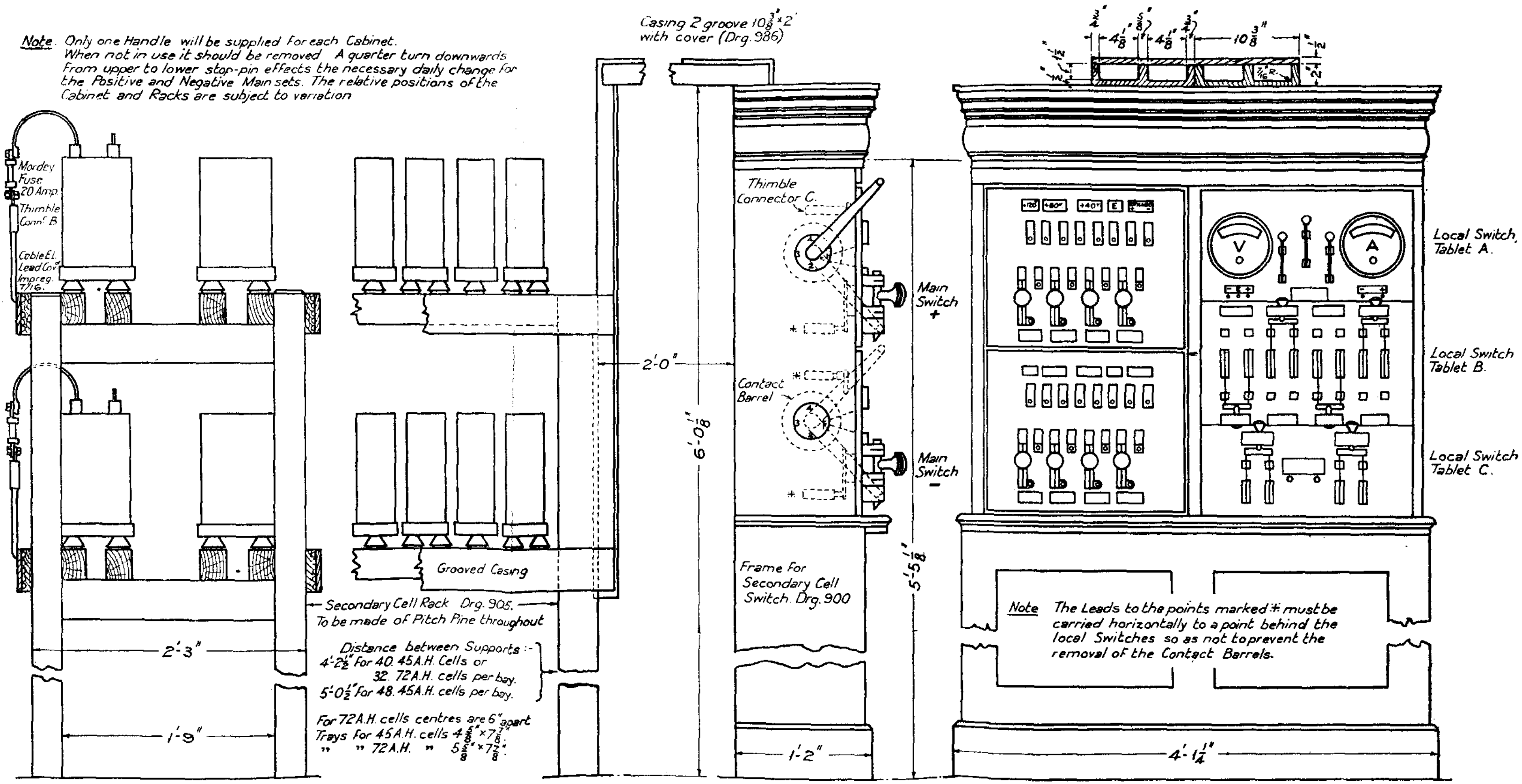
Further refinements may be necessary in calculating the working current and time for special cases, but the broad principle remains the same.

For Quads.	4 ×	50 ×	12 =	2,400	milliampère-hrs. per day.
For D.C.S.X.	10 ×	30 ×	10 =	3,000	milliampère-hrs. per day.
For D.C.	8 ×	30 ×	4 =	320	milliampère-hrs. per day.
For S.N.S.	4 ×	20 ×	4 =	320	milliampère-hrs. per day.
			Total	6,680	

Dividing by 1,000 to reduce to ampère-hours, we find that the total discharge from the cells each day is 6·68 ampère-hours.

Now, for reasons which will be apparent when the Secondary Cell Switch Cabinet is described, each set of cells works for 3 days, but to allow a margin of safety the capacity of the battery should be calculated on a four-day output.

A further margin is also given by the method of calculation indicated above, since no allowance is made for the fact that as the sets of cells are shifted from the 40 V. position to the 80 V. and the 120 V. positions they do not supply current to the circuits worked from the lower voltages, and also that the load on the circuits is shared by the positive and negative sides of the secondary battery. So far as the duplex circuits are concerned, the "spacing" currents will, in some cases, approach a value of about 75 per cent. of the total load on the circuits, but this is usually compensated for at a Down office by the load on negative voltage C.B.S. circuits and at TS.,



SECONDARY CELL WORKING-TELEGRAPHS.

BATTERY ROOM SWITCH CABINET AND SECONDARY CELL RACKS.

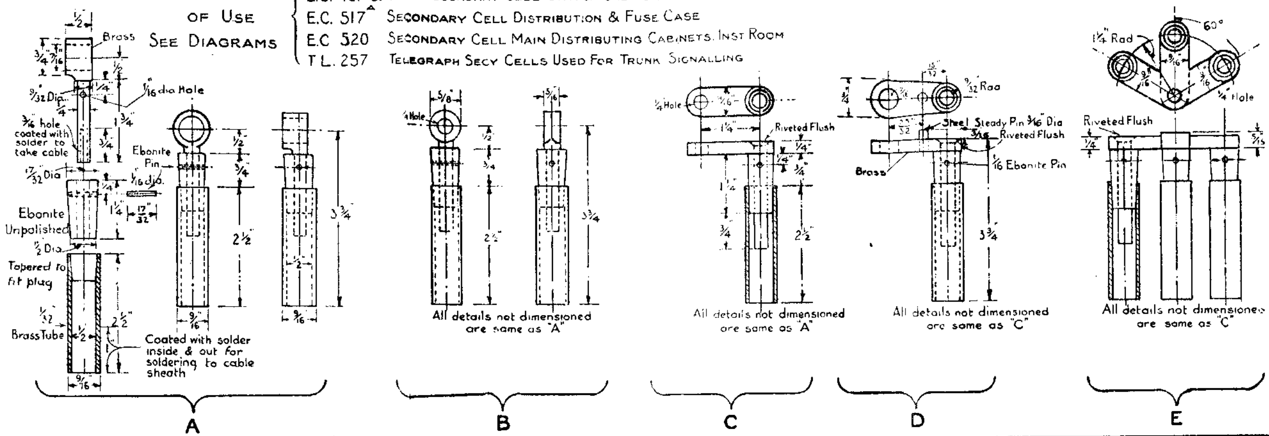
Fig. 4.

SECONDARY CELL WORKING

CONNECTORS, THIMBLE AND FIBRE TUBE FUSES

For Conditions of Use See Diagrams:

- E.C. 419 & 420 Cabinets Charging 6 Voltages & Ditto 8 Voltages
- E.C. 487 & 518 Secondary Cell Switch Cabinet. Telegraphs
- E.C. 517 Secondary Cell Distribution & Fuse Case
- E.C. 520 Secondary Cell Main Distributing Cabinets. Inst Room
- T.L. 257 Telegraph Secy Cells Used For Trunk Signalling



CONNECTORS, THIMBLE, "A", "B", "C", "D", & "E".

FIBRE TUBE FUSES

(See Also Diagm. E.C. 1091.)

Used on Secondary Cell Racks – Diagram E.C. 518

" " " " Main Distributing Cabinets – Diagram E.C. 520

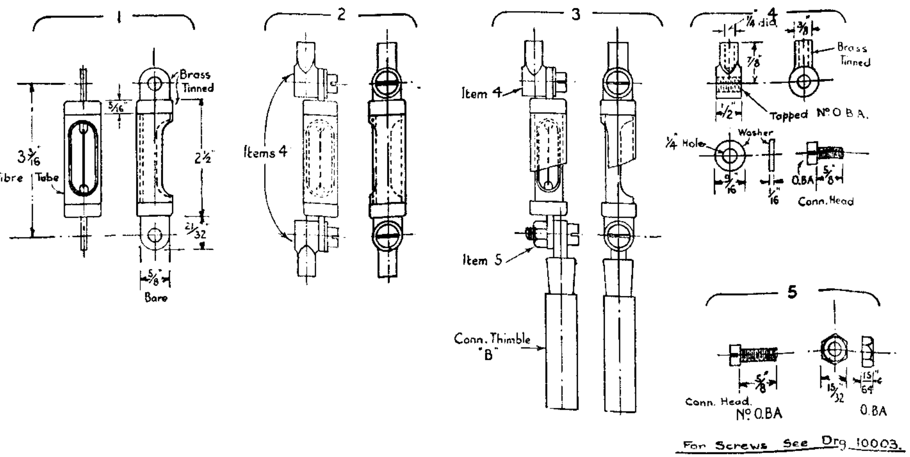


Fig. 5.

FUSES-STOCK TITLES & DETAILS

1. Fuse Nº 3/3 (or Nº 3/12)

   Wire fuse silver, 6 mils," used for Nº 3/3
   " " " 15 " " " Nº 3/12.

2. Fuse Nº 3/3 CIR (or Nº 3/12 CIR)

   For connecting to I.R. Cables
   Includes:–
   2 Connectors for fuses fibre tube.
   1 Fuse Nº 3/3 (or Nº 3/12).

3. Fuse Nº 3/3 CLC (or Nº 3/12 CLC)

   For connecting to lead covered cables
   Includes:–
   1 Connector, for fuses, fibre tube.
   1 Connector Thimble B.
   1 Screw and nut for fuses fibre tube.
   1 Fuse Nº 3/3 (or Nº 3/12).

4. Connector For Fuses Fibre Tube

   Includes Screw Nº 0.B.A. 5/8" & washer.

5. Screw and Nut for Fuses Fibre Tube

   Includes Screw Nº 0.B.A 5/8 long, brass, with ordinary nut.

which is an Up office to all provincial offices, by the load on positive voltage C.B.S. circuits.

If, then, a four-day output is taken for the case under discussion, the capacity of the battery should be $4 \times 6{\cdot}68 = 27$ ampère-hours approximately. In a similar manner the capacity of the Local Battery sets may be calculated, except that in this case a three-day output only need be provided for.

The standard sizes of cells used for Telegraph purposes are 8, 16, 24, 32, 40 and larger than 40 ampère-hours ; therefore, in the case under discussion the 32 ampère-hour type would be adequate, and possibly, for the reasons already mentioned, the 24 ampère-hour size might be sufficient.

Information concerning the setting up, initial charging, care and maintenance of secondary cells is contained in Pamphlet No. G.1.

In order that there shall be no leakage *viâ* the surfaces of the containing vessels, each cell is mounted on mushroom insulators, or in the case of the smaller types, sets of 3 to 5 cells, according to size, are placed on trays, insulating, No. 1, which are in turn supported by mushroom insulators.

The cells are carried on standard battery racks which are fitted with grooved casing for the leads between the cells and the secondary cell switch cabinet (see Fig. 4).

Each cell is numbered, and for this purpose Labels No. 42 are used.

Battery Fuses.—A fuse is required for each lead between the battery and the secondary cell switch cabinet, a total of 24 being required. In order that the cells shall be protected against any fault in the wiring the fuses are fitted as near to the cells as possible.

The current-carrying capacity of the fuses is determined by the maximum charging current they are required to carry, the rating current of the standard fuses or that current which they will safely carry being 3 and 12 ampères. Where larger fuse wire is necessary this must be specially provided.

The fusing current in each case is about twice the rated value.

The type of fuse used for Universal Battery working is illustrated in Fig. 5.

It has two fibre tubes, out of each of which a section about two-thirds the length of the tubes is cut. The inner tube is the longer, and on each end of it is fixed a brass cap having a large external lug for the connectors and a smaller internal lug for the fuse wire.

The outer fibre tube fits fairly loosely over the inner tube, and can be turned so that the openings in the tubes coincide, a means of inspecting the fuse wire which extends from one brass cap to the other through the inner tube, being thus afforded.

Normally the outer tube is in such a position that the fuse is entirely enclosed. The fuse is thus prevented from splashing when it melts, and to some extent the temperature of the surrounding air is more constant, thereby ensuring more accurate fusing for a given current. Incidentally the fuse wire is more or less protected from the acid spray from the cells.

The connection between the cell and the fuse may be made by means of a short length of neatly bent heavy copper wire to one end of which is sweated a connector for Fuse Fibre Tube (see Figs. 4 and 5), and to the other a connector suitable for the connection bolts of the cell in use. The copper wires and the connectors should be coated heavily with **Anti-Sulphuric paint,** red being used for the positive connector and black for the negative.

LEADS TO SECONDARY CELL SWITCH CABINET.

Twenty-four leads are required, *i.e.*, two for each of the eight 40-volt main sets and two for each of the 24-volt local sets. Cable E.L. I.P.C. 7/16 should be used in the absence of instructions to the contrary.

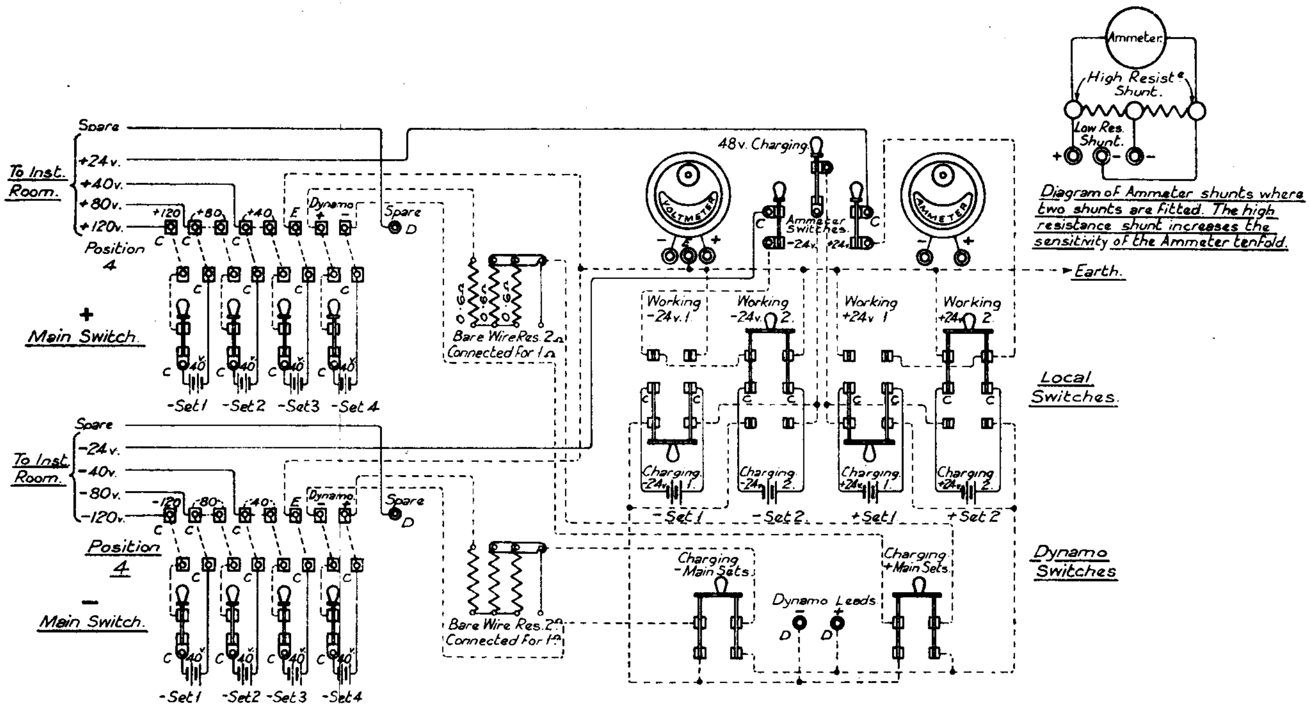
Floor chases in the Battery Room are not desirable, and the Battery Leads should be carried from the racks to the Switch Cabinet in overhead wood troughing (see Fig. 4), Casing and Cover T. 6¼ being used. In view of the corrosive action of acid spray from the cells, a minimum of metal work should be used and the whole of the casing should be carefully covered with Anti-Sulphuric paint.

The leads are terminated at the Battery Rack by " Thimble Connectors B," and at the Secondary Cell Switch Cabinet by " Thimble Connectors C " (see Fig. 5).

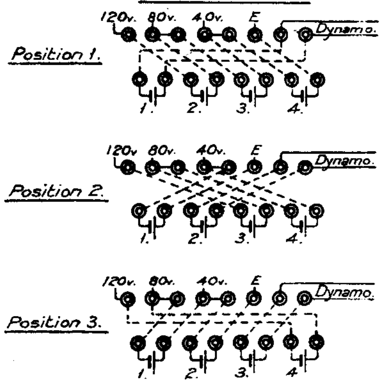
These consist of a brass connector over which a tapered piece of ebonite is fixed and a brass tube which fits tightly on the ebonite, the difference between the various types being only in the shape of the external end of the brass connector.

Since the finish and neatness of a Secondary Cell installation very largely depends on the uniform appearance of the termination of the leads and the fuse connections, very great care should be taken with this part of the work. The bare wire connections between the cells and the fuses should be of the same length so that the fuses may be on the same level throughout the tier of the cells, and the bends should be made over a template so that they may have the same curvature. Incidentally the lugs between continuous cells should also be bent over a template.

The leads to the Secondary Cell Switch Cabinet should be carefully cut to length so that there is no untidy sag before they enter the Battery Rack casing.

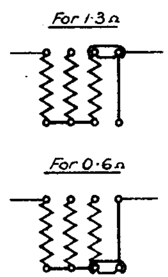


Internal Connections of Main Switches.



Note:- Connections shown by dotted lines will be made before the Cabinet is issued. Connections shown by full lines will be made locally.
A "Thimble, Connector C" will be fitted at each point marked "C". (32 req.)
and a "Thimble, Connector D" at each point marked "D". (4 req.)
The Connectors will be fitted in the Cabinets before issue.
Internal connections will be made by means of Taped Copper Strip, and 7/16 E.L. Cable. The latter will be terminated at each point in an ordinary brass connector.
The lead covered leads to main switches should be taken across horizontally to a point behind the local switch tablets before passing out of the Cabinet.

Connections of Bare Wire Resistance Frames.



SECONDARY CELL SWITCH CABINET - TELEGRAPHS.

See Diagrams E.C. Nos. 488 & 518.

Fig. 6.

To fit the thimble connectors the lead sheath is carefully stripped from the impregnated paper insulation ; the latter is then stripped from the conductor to within $\frac{3}{4}$ in. from the lead sheath and the edges neatly trimmed. The conductor is cleaned and tinned, and finally cut to a little less than $\frac{3}{4}$ in. from the paper insulation. Acid flux must not in any circumstances be used. A paste composed of tallow and resin will be found satisfactory. The hole in the connector, the tinned end of the brass tube and the end of the lead sheath of the cable are now carefully cleaned, and the brass tube is forced down over the lead sheath of the cable so that the top end comes below the end of the lead sheath, the tinned end of the tube being passed over first. It may be found that the lead sheath is slightly too large for the brass tube, and if this be the case the lead must be carefully scraped down to fit, no more lead being removed than is absolutely necessary.

The connector is now carefully sweated to the end of the conductor, care being taken not to use sufficient heat to burn the ebonite. The brass tube is then forced up to the ebonite plug and turned once or twice to ensure close contact ; otherwise, in cases where the connector points downwards or is horizontal, the resin oil impregnation has a tendency to run out between the plug and the tube.

Finally, the tinned end of the tube is sweated to the sheath of the cable, and all the exposed brass parts are coated with Anti-Sulphuric paint.

THE SECONDARY CELL SWITCH CABINET.

(Figs. 4 and 6.)

This cabinet serves three main purposes :—

(1) It provides a means of connecting the various sections of the battery to the charging mains.

(2) It furnishes a means of testing the various sections of the battery.

(3) It provides the necessary switching devices for changing the sections of the main battery from one position to another in the discharge circuit, so as to equalise the discharge from different sections of the main battery.

The cabinet comprises five slate tablets mounted in an iron-framed wood cabinet (see Fig. 4). The two tablets on the left are identical in all respects. They each mount :—

12 plug sockets with extensions at the back terminating in double spring V-shaped contacts and screws for Thimble Connectors C.

1 plug socket without spring contacts.

4 single pole switches, one-way, with knife contacts, plug sockets on the contact blocks, double spring contacts at the

back of the top contact blocks and screws for thimble connectors on the bottom contact blocks.

1 rotating contact barrel.

Below these tablets in the wood frame are mounted two bare wire resistance frames fitted with three coils, each having a resistance of two-thirds of an ohm.

The top tablet on the right carries :—

1 voltmeter with 3 plug sockets.

3 single pole one-way switches with knife contacts and plug sockets on both contact blocks.

1 ammeter with two plug sockets. (When a second shunt is fitted three plug sockets are provided.)

The middle tablet on the right carries :—

4 double pole two-way switches.

The bottom tablet on the right carries :—

2 double pole two-way switches.

2 plug sockets.

The external connections are all made by means of Thimble Connectors, the requirements being :—

32 Thimble Connectors C.

4 Thimble Connectors D.

The rotating contact barrels on the left-hand tablets, together with the double spring contacts mentioned above, constitute the " Rotary Switches." The barrels are carried on brackets fixed to the iron framework of the cabinet, and their spindles protrude through the left side of the cabinet where a handle can be fixed to rotate the barrels. The brackets are so fixed that the edges of the brass discs of the barrels engage with the spring contacts.

Each barrel has four positions. These are indicated by marks on circular plates fixed to the side of the cabinet, and the segments of the discs are so joined up that the connections between the spring contacts are varied as shown in Fig. 6 when the barrels are rotated. The barrels consist of a central hollow iron core with end caps which carry the spindles. On each iron core are fixed sixteen ebonite rings. Eight of these carry full brass discs and the other eight carry segmented brass discs, each of which is divided into four sections.

The discs are fixed to the ebonite rings by means of screws through brass blocks on the faces of the discs. Other brass blocks are provided to take connecting wires which pass from disc to disc through the hollow iron core.

The barrels are rotated through one sector each day and thus the sections of the main battery successively occupy the 40-volt, 80-volt, 120-volt and charging positions.

The purpose of this arrangement is to ensure that each section of the battery shall in turn occupy the most heavily and least heavily worked positions in the discharge circuit.

It is evident that the set occupying the 40-volt position will supply current for all the voltages, while the 80-volt set supplies that for the 80 volt and 120 volt, and the 120-volt set supplies current for that voltage only.

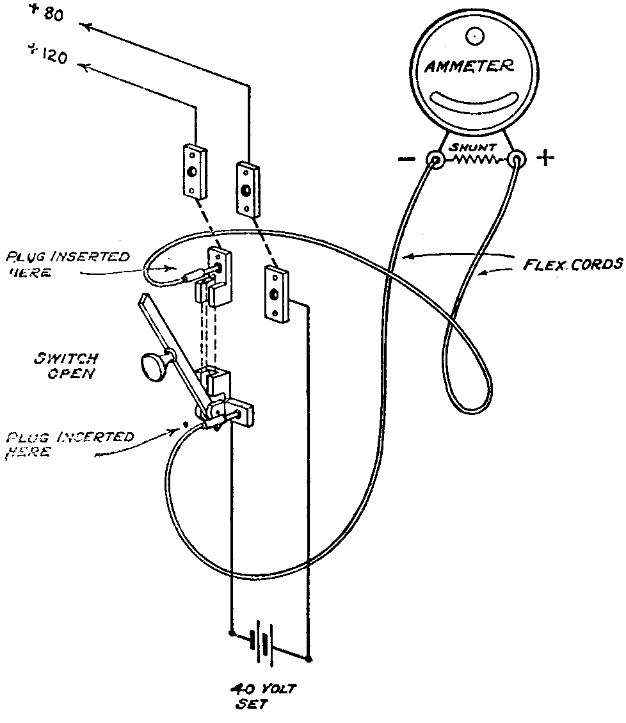


Fig. 7.

A reference to Fig. 6 will show that with the switches on the left-hand panels in the positions indicated, the main cells are joined up in accordance with Fig. 3, the rotary switches being in position 4. The inset diagram in Fig. 6 shows how the connections are varied by turning the rotary switch so that sets 1, 2 and 3 are successively joined to the dynamo leads.

In order that the rotary barrels shall be easily accessible for examination, cleaning or removal, the battery and instrument room leads connected to the left-hand panels should be carried horizontally from the plug sockets on those panels to a convenient point behind the " Local " Tablets before they are led vertically into the chases.

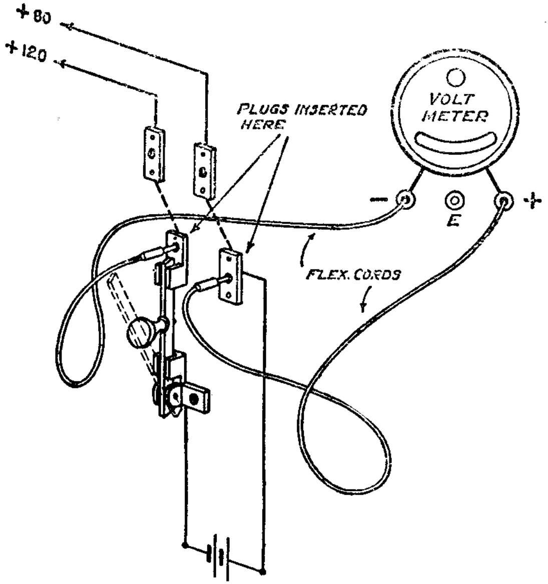


Fig. 8.

The plug sockets are provided so that by opening any switch and connecting the plug sockets on the bottom of the switch and that on the corresponding plug socket contact with the plug socket associated with the ammeter by means of plugs and cords, the current being delivered by that particular section of the battery can be measured. They also permit of temporary connections being made if the barrel is removed.

The voltmeter is similarly connected by inserting a pair of pegs and cords into the plug socket contacts and into the voltmeter plug sockets.

The conditions for measuring the current being delivered by the set connected to the + 120V. leads in Fig. 6 are shown in Fig. 7, the voltage test being indicated in Fig. 8.

The double pole switches on the bottom right-hand tablet connect the dynamo with the main sets for the time being associated with the dynamo leads on the left-hand panels.

The Local Battery switching equipment is accommodated on the middle panel on the right of the cabinet. This equipment is of a much simpler character than that for the main sets, because on each side of "Earth" only one voltage is concerned, and on each side also a duplicate battery is provided, consequently the conditions to be met are practically those formulated in the first paragraph of this pamphlet, except in one particular.

A battery of 24 volts is somewhat small to be economically charged from the dynamo usually installed; therefore the middle switch on the top right-hand panel is provided, and the connections of the four switches on the middle panel are so arranged that both spare sets of the "Local" battery may be charged in series, thus raising the voltage to be dealt with by the machine to 48 volts and also making it possible for the "Local" to be charged in parallel with the "Mains."

The two outer switches on the top right-hand panel afford a means of taking readings of the current flowing through the two batteries on the local discharge circuits.

A recording ammeter is sometimes provided with the installation, so that records may be taken of the discharge currents when necessary.

With the switches in the positions shown in Fig. 6 the full connections of the whole board, eliminating all switching apparatus, are represented in Fig. 9.

It will be observed that provision is made for charging the 40V. main sets in "parallel" with the two local sets, which in series have a voltage of 48 volts when the local conditions and the capacity of the charging machine permit of this being done. The difference in voltage must be counterbalanced, otherwise, if the charging current for the locals were correct, the two main sets would be taking too much.

The two bare wire resistances are provided for this purpose. They are made adjustable, so that varying charging currents may be allowed for.

Thus, if the normal charging current be eight ampères, then the resistances must be joined up for one ohm, because the excess voltage to be absorbed is eight, and the current passing multiplied by the resistance equals the voltage drop along the resistance. If the charging current be twelve ampères, then the resistance must be two-thirds of an ohm, since 12 multiplied by $\frac{2}{3}$ equals 8.

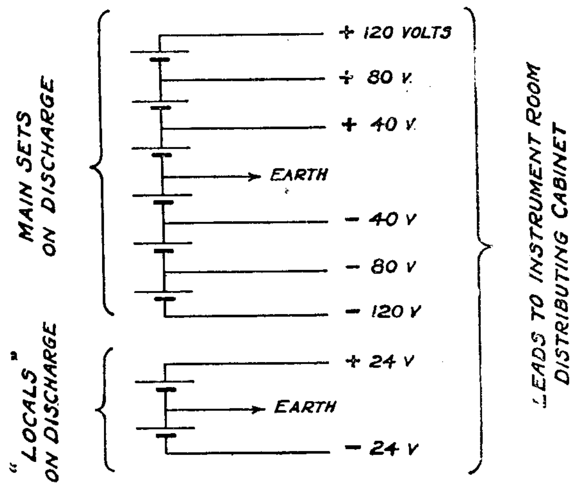
The electro-magnetic cut-out associated with the dynamo is a safety device to disconnect the dynamo from the cells in the event of—

(*a*) the dynamo voltage falling below that of the battery, or

(*b*) excessive current flowing in the charging circuit.

Its action and design are fully described in Pamphlet No. G.1

The Leads between the Secondary Cell Switch Cabinet and the Secondary Cell Main Distribution Cabinet (ten in number) should be accommodated in separate troughing or chases.



CHARGING CIRCUIT

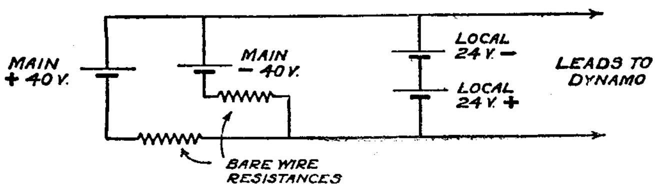
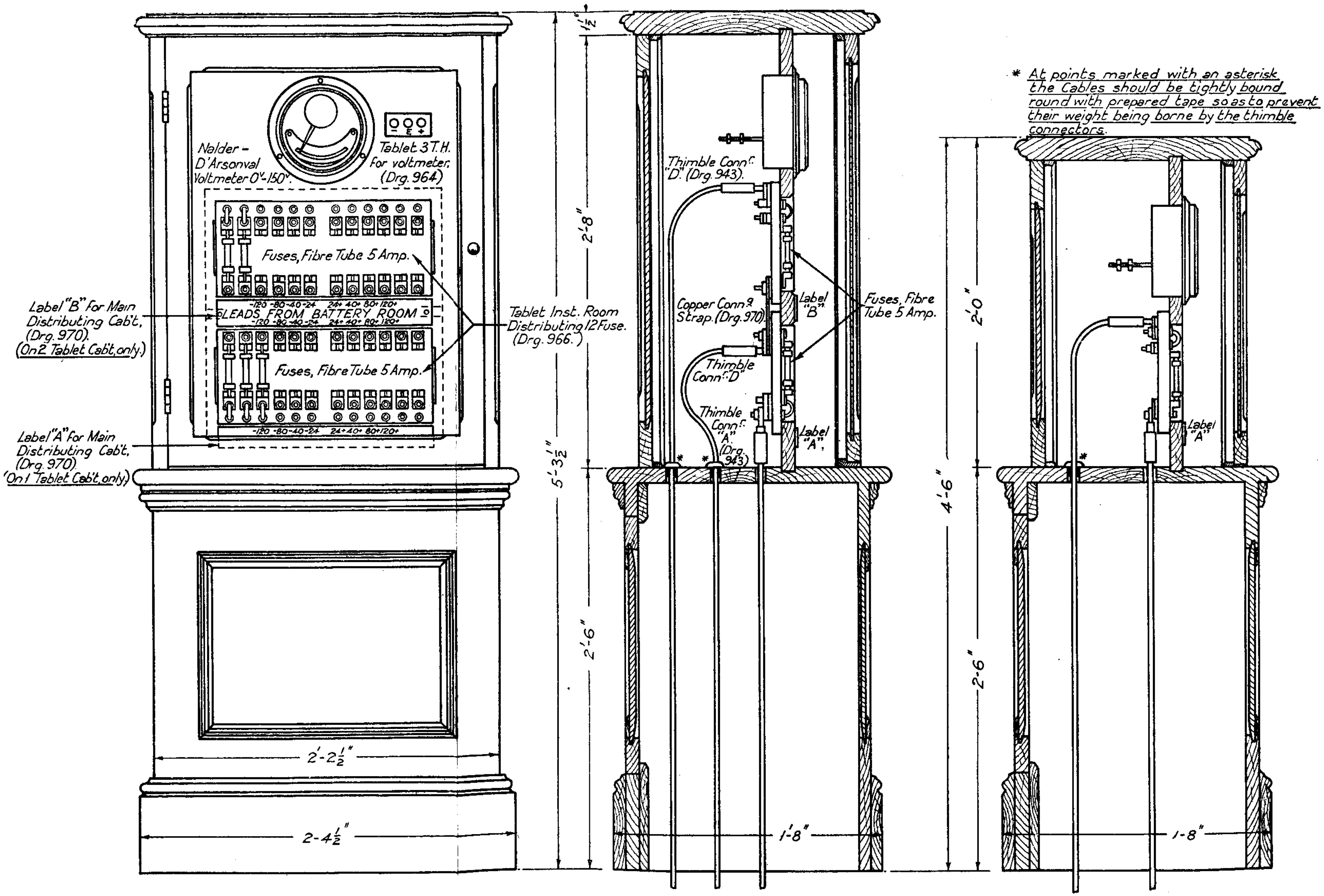


Fig. 9.



SECONDARY CELL WORKING- TELEGRAPHS.

MAIN DISTRIBUTING CABINETS, INSTRUMENT ROOM, (1 AND 2 TABLETS.)

Fig. 10.

In new offices the wall and floor chases are specially provided, and no troughing is necessary, but in offices where chases have to be cut under existing floors, troughing sheet iron, with cover for floors, is fixed, and wall troughing and cover is used on the surface of walls.

The size of the conductors is determined by the rule that the fall of potential along them, when maximum current is flowing, should not exceed one per cent. of the normal voltage of the current passing. This rule is determined not by the safe current which the leads will carry, but by the necessity for keeping the resistance of the battery and battery leads below a certain critical point for universal battery working.

If the length in feet multiplied by the maximum current and divided by the normal voltage does not exceed 15·6, then Cable E.L. I.P.C. 7/18 will suffice. In other cases Cable E.L. I.P.C. 7/16 should be used.

The cables are terminated at the Switch Cabinet and at the Main Distributing Cabinet on Thimble Connectors.

THE SECONDARY CELL MAIN DISTRIBUTING CABINET.

(Fig. 10.)

This cabinet is fitted in the Instrument Room. It furnishes a convenient central distributing and testing point in the Instrument Room for leads and batteries, and also provides facilities for the insertion of fuses before the power is distributed to the Instrument Tables.

In large Instrument Rooms, where the Main Distributing Cabinet is generally fitted in the centre of the room, a two-tablet cabinet is provided, and separate distribution cables are carried to the tables on either side of it, but in moderately sized and small Instrument Rooms a one-tablet cabinet suffices, the cabinet being placed conveniently at one end of the room.

The single tablet cabinet consists of a framed wood cabinet in the upper portion of which a voltmeter, a three test hole tablet and a slate tablet carrying twelve fuse mountings are fitted, a glass panelled door affording access to the front of the equipment.

Each fuse unit consists of two fuse clips with test holes, one " U " link, one fibre tube fuse and one separate test hole. The latter, together with the " U " link, is provided so that an ammeter can be inserted in the circuit of any voltage supply when desired without removing a fuse.

Voltage tests may be taken by inserting one peg of a pair of pegs with cord into the test hole on the battery side of the fuse, and the other into the negative or positive test hole on the three-test-hole tablet, the other side of the voltmeter being earthed by means of a " U " link at the three-test-hole tablet.

The size of fuse wire used is determined by the maximum current to be carried by any lead, and should not be larger than necessary, since the whole object of inserting fuses is to protect the battery and wiring, and the use of a larger fuse than necessary may result in serious damage to the cells.

The leads from the switch cabinet are terminated on the bottom row of fuse clips by means of Thimble Connectors A, and the Instrument Table leads on the separate test holes at the top of the tablet by Thimble Connectors D. It is necessary to pass the cables through the holes in the top of the lower section of the cabinet before the thimbles are sweated on.

In order that the soldering on the horizontal thimble connectors shall not be strained, the leads should be bound with prepared tape to form a shoulder where they pass through the holes in the top of the lower section of the case.

The two-tablet case is similar in all respects to the one-tablet case, except that it is larger and accommodates a second fuse tablet, the battery leads being connected to the latter by means of brass links from the first tablet.

INSTRUMENT ROOM LEADS.

The Instrument Room Leads, comprising eight cables, are carried in chases in the fireproof floors, where such are provided, or in sheet iron troughing where there are no fireproof floors. They are carried continuously from the Main Distributing Cabinet to the most distant Instrument Table cut-out, as nearly as possible under one end of the Instrument Tables (see Fig. 11).

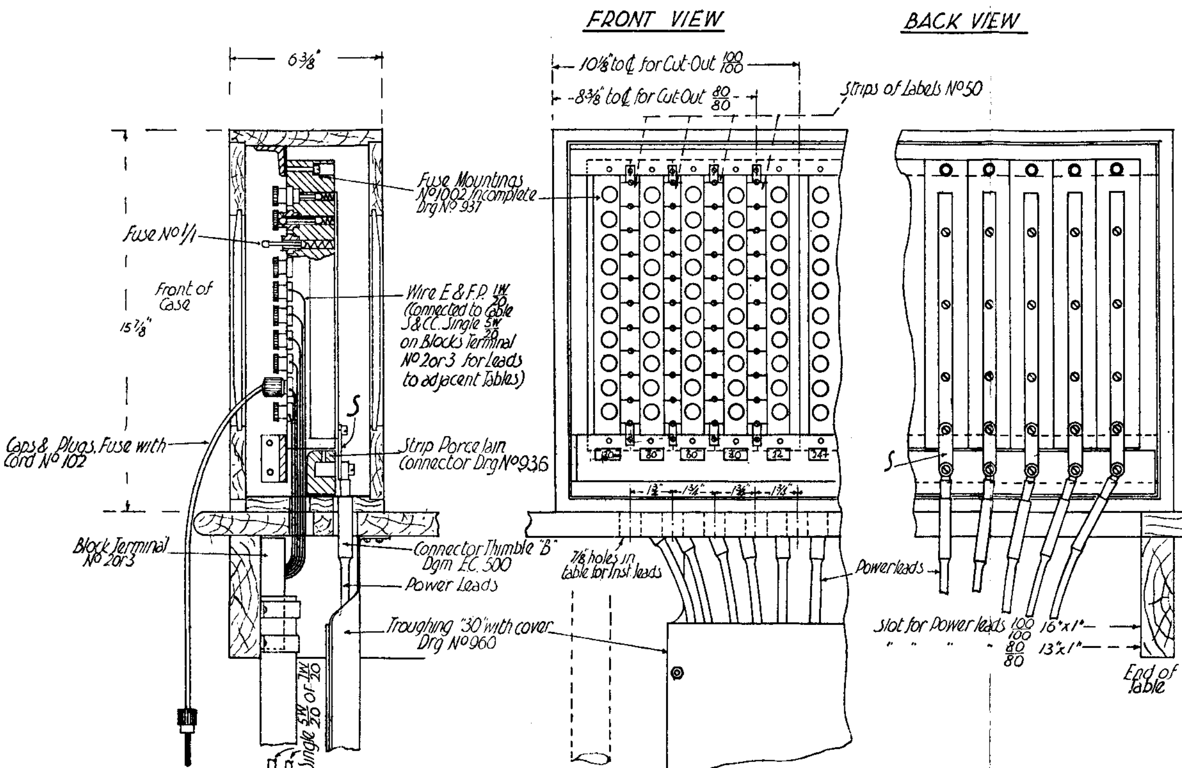
Short lengths of cable are teed on to the main leads to connect intermediate Instrument Table cut-outs.

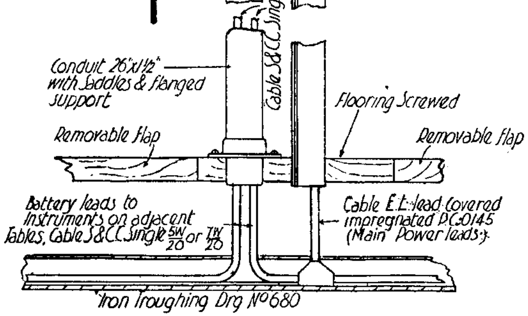
Materials for " T " joints are provided, and consist of one shaped piece of sheet lead, one piece of compounded paper of the same shape but somewhat smaller, and two yards of compounded tape (see Fig. 12).

The sheath of the main cable is first cut away for about 2 in. immediately below the vertical troughing to the tables, and the conductors are bared for about 1 in. in the centre of this space. The end of the T cable is bared, and the conductors are neatly wrapped round the conductors of the main cable, four of the strands being laid in one direction and three in the other with a reversed twist. The joint is then soldered and covered with the compounded tape.

TELEGRAPH SECONDARY CELL INSTALLATIONS
CUT OUT No 3 80/80 & 100/100

FOR DETAILS SEE DRG. No 939





Notes:- One Case will generally serve three Instument Tables & should be placed at one end of the Central Table (with the front of the Case facing the back of the table).

For battery leads from the Case to the Instruments on the same Table, Wire E & Flameproof 1/W 20 to be used.

For battery leads passing beneath the flooring to adjacent Tables Cables S & C Core single 5/W 20 or 7/W 20 should be used, terminating at each end in Blocks Terminal No 2 or 3; a 20 lbs Flameproof wire being used from the Block Terminals to Cut-Out No 3 & the Instrument terminals.

The cover of the horizontal Iron Troughing beneath the floor to be cut away sufficiently to allow the leads to enter & lie alongside the Main Power leads. Where the main horizontal Troughing is too narrow for this a separate troughing should be provided. The main power leads are connected by Tee Joints & "Connectors Thimble" as shown, to the brass bars on the back of the Fuse Mntg, Fuses No 1/1 being placed between these bars & the screwed Caps on the front, to which are connected the instrument leads.

If a change of voltage is desired on any particular circuit the Fuses No 1/1 should be removed & replaced by the ebonite plug & cap of "Caps & Plugs Fuse with Cord No 102" the other cap being screwed over a fuse to a spare position on the voltage required.

Two or more complete strips may be connected to the same power lead by placing the connecting straps "S" horizontally instead of vertically.

For particulars of Engraving See Engraving Sheet No 19

SCHEDULE OF APPARATUS

CASES	Secondary Cell Cut-Out 80/80 or 100/100 fitted. These include without special mention
1	Strip Porcelain Connector 8/8 or
1	" " " 10/10
8 or 10	Connectors for Porcelain Connector Strips
4 or 6	Caps & Plugs Fuse with Cord No 102
8 or 10	Fuse Mountings No 1002
8 or 10	Strips, 10 Label for Cut-Out No 3
8 or 10	Straps Connecting for Cut Out No 3
10	Labels No 21 White for 100/100
	ITEMS TO BE SEPARATELY REQUISITIONED
80 or 100	Fuses No 1/1

Fig. 11.

The compound paper is now laid symmetrically on the sheet lead, and the two are tamped over the joint so that the edges of the lead sheet meet and enclose the three ends of the cable sheaths. The edges of the lead sheet are then carefully soldered together.

The cables from the floor troughing to the table cut-outs are accommodated in Troughing Iron 30 in. with cover (see Fig. 11). This troughing is screwed to the under side of the Instrument table top, so that the back of the troughing coincides with the inner side of the slot which is cut in the table

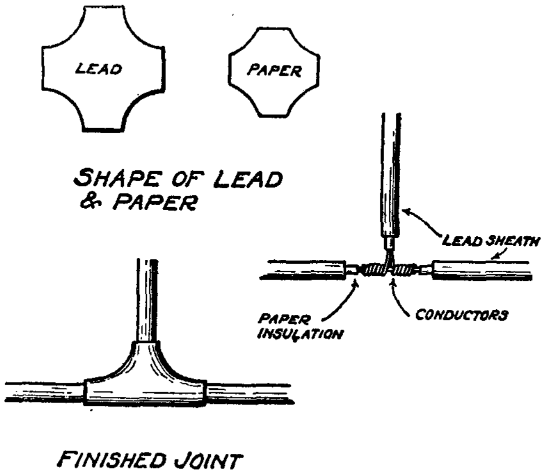


Fig. 12.

under the slot in the back of the bottom of the cut-out. The bottom of the troughing passes through a wood strip, which crosses the floor troughing, and which is permanently fixed, a slotted hole being cut in it to receive the end of the troughing.

The ends of the leads at the cut-outs are terminated by means of Thimble Connectors B.

It is necessary that the T cables shall be very carefully cut to length, otherwise the main leads are suspended from the T cables, or the latter sag.

The size of the conductors of the Instrument Room leads must be such that when current is being taken by all circuits served from any particular lead, the current in ampères multiplied by the resistance in ohms must not exceed $0 \cdot 5$ per cent. of the normal voltage carried by the lead.

Cable E.L. I.P.C. 7/18 strand meets all requirements where the total length of the lead is less than 100 feet, and may be used without calculation.

Cut-Outs No. 3$\frac{80}{80}$ and **3$\frac{100}{100}$** (see Fig. 11) are used for the purpose of distributing power to the individual circuits on the Instrument Tables. They also afford a convenient point for the insertion of separate circuit fuses and for changing circuit voltages to meet working conditions. Cut-Out No. 3$\frac{80}{80}$ provides for 40 D.C. circuits and four positive and four negative voltages. No. 3$\frac{100}{100}$ provides for 50 D.C. circuits and five positive and five negative voltages. Alternatively, if larger numbers of circuits than can be accommodated on one strip require the same voltage, then two strips may be combined.

As a general rule, one cut-out per three tables is found to be sufficient.

The No. 3$\frac{80}{80}$ cut-out consists of a polished wood case with removable front and screwed back. A slot extends across the full length of the back of the bottom of the case to accommodate the power leads, and there are eight holes at the front of the bottom to take the circuit battery leads.

An earthenware strip carrying eight connection blocks is fixed horizontally along the bottom of the case, and to these connection blocks are attached the thimble connectors of the power leads.

Above the horizontal earthenware strips are fixed eight vertical strips. On the back of each of these strips is screwed a brass bus bar, covering ten holes which pass from back to front of the blocks. The bus bars are connected to the power lead strip by means of brass links.

Into the front ends of the holes of the vertical strips are fixed hollow connecting blocks with screwed bosses which protrude beyond the face of the earthenware strip. The holes in the connecting blocks are large enough to take Fuses No. 1/2 (Glass tube 1·7 amp. fuses), and in the backs of the holes in contact with the bus bars are placed spiral springs. Screwed caps are fitted on the screwed bosses.

Connection can thus be made between the connection blocks and the bus bars by pushing a glass tube fuse into the hole in the block and screwing on the cap, the spiral spring ensuring firm contact between the bus bar, the fuse ends and the connection blocks. The battery leads to the circuits are fixed to the sides of the connection blocks by means of screws.

Should it be necessary at any time to vary the voltage on a particular circuit this may be done by flexible cords having at one end a screwed cap and at the other a screwed cap with an ebonite plug extension. The cap with the ebonite plug is screwed to the normal connection block and the cap without plug is screwed to a spare block on the strip carrying the required voltage, a glass tube fuse having first been inserted into this block.

The ebonite extension is provided to ensure that the fuse is withdrawn from the home position and that the spiral spring is pressed well away from the contact block.

The cut-out No. 3$\frac{100}{100}$ is similar to No. 3$\frac{80}{80}$, except that ten contact blocks are fitted on the horizontal earthenware strip and ten vertical strips are provided instead of eight.

Battery Leads to the circuits on the same table as the cut-outs should be of Wire, Enamelled and Flameproof 1/20, those for circuits on contiguous tables being Cables S. and C. Core 5/20 or 7/20.

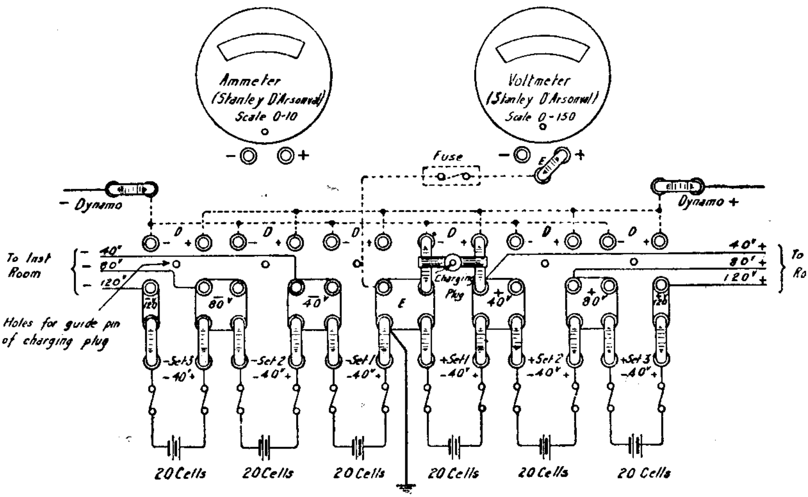


Fig. 13.

These cables should be terminated at either end on strips connection 5 or 7 tag, fitted on the inside of the rails of the tables, and connected thence to the instruments and cut-outs by means of Wire E. and F.P. 1/20.

The cables are carried from the cut-out tables to the floor chase, and from thence to the other tables in Conduit Steel 26 in. × 1½ in. The conduit is fixed to the table rail by two saddles and to a strip of wood across the chase by a flanged support.

A final protection, for avoiding the stoppage of a number of circuits by a fault on one, is provided at the circuits in the form of battery resistances which prevent earthing of the battery by earth or contact faults on the circuits.

For voltages of 80 and over Lamps, Glow, 16 c.p. 100 volts, carried in stands with double lamp holders, are provided, and for voltages under 80, metal-cased resistances are fitted.

The value of the resistance is approximately 2^{w} per volt.

No resistances are fitted in the local battery leads.

An important modification in the method of terminating the cables S. and C.C. 5 wire/20 and 7 wire/20 has recently been introduced. Each of these cables should be terminated on a " Block, Terminal, No. 3." The sheath of the S. and C.C. cable should be passed through the hole in the terminal block, and after the conductors have been connected to the terminals Compound No. 5 should be pressed well into the slot so as to form an effective seal. From the cut-out No. 3 to the terminal block at one end of the S. and C.C. cable and from the terminal block at the other end to the instruments " Wire E. and F.P. 1 wire/20 " should be used.

ALTERNATIVE CHARGING DEVICES FOR SMALL OFFICES.

The secondary cell switch cabinet, with its elaborate rotary switches, is a costly item and, therefore, its use can be justified only at comparatively large offices. An alternative arrange-

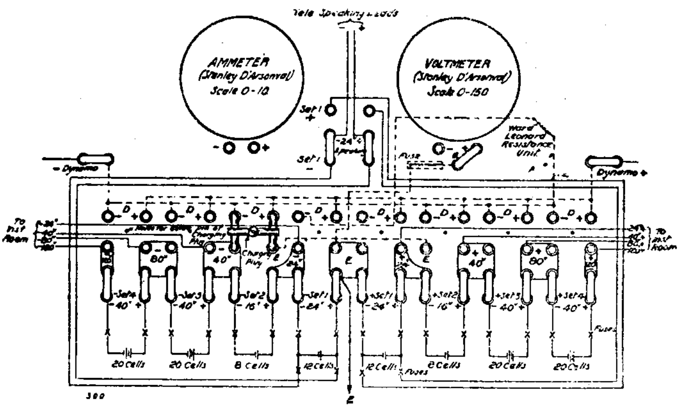


Fig. 14.

ment, therefore, has been designed which, being much less costly and obviating the necessity for spare batteries, is suitable for installation at comparatively small offices.

In this arrangement the secondary cell switch cabinet is replaced by a secondary cell charging cabinet with 6 voltage or 8 voltage tablet (see Figs. 13 and 14).

The essential feature of these cabinets is a tablet carrying, in the case of the 8-voltage cabinet, four horizontal rows of 16 Test Holes and, in the case of the 6-voltage tablet, four rows of 12 Test Holes. The special points to be noted with regard to the tablets are that the Test Holes in the two middle rows are grouped by means of brass plates, and that alternate vertical rows are spaced differently.

The latter provision is made so that the charging plug (Fig. 15) cannot be placed in a wrong group of holes.

As a further precaution, the plug is provided with a guide pin and corresponding holes are bored in the tablets.

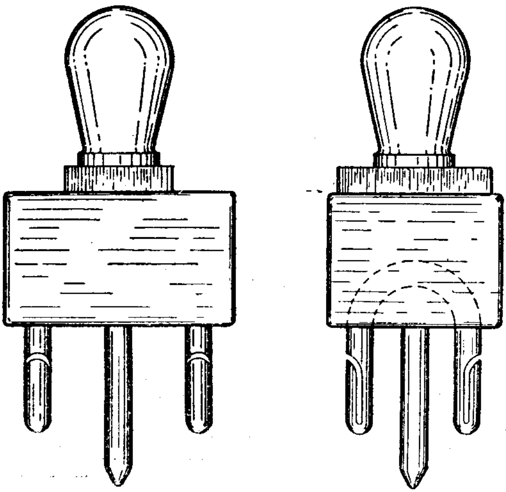


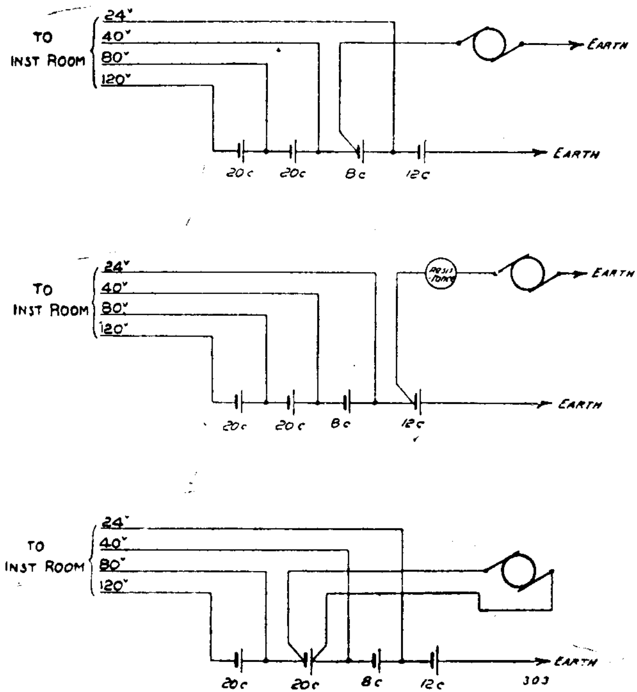
Fig. 15.

In the case of the 8 voltage installation, the cells are arranged in four groups of 20, two groups of 8 and two groups of 12, thus furnishing positive and negative voltages of 24, 40, 80 and 120, the 40 volts being supplied by the groups of 12 and 8 cells in series.

The connections of the Test Holes are so arranged that by inserting the charging plug in the two top rows of Test Holes each set of 20 cells may be charged separately, while with the plug in the position indicated in Fig. 14, the set of 8 cells is charged in series with the set of 12.

By inserting the plug in the next group of Test Holes to the right the set of 12 cells can be charged separately through a " Ward Leonard " resistance unit.

This provision is made so that the 12 cell sets, which are used for telegraph locals and, in some cases, also for telephone signalling purposes and which are, therefore, generally of



VARIOUS METHODS OF CONNECTING DYNAMOS TO CELLS.

Fig. 16.

greater capacity than the remainder of the cells, may be charged alone after the 8 cells associated with them to form the 40-volt set have been fully charged.

Six auxiliary Test Holes are provided to accommodate the tap for telephone purposes.

The remaining fittings of the cabinet comprise an ammeter, a voltmeter and two sets of U links which form part of the dynamo circuit.

It will be observed that the cells are charged while they are actually working and that, therefore, no provision of spare batteries is required. If at any time it becomes necessary, owing to the development of faults or for other reasons, to withdraw a set of cells from service, they may be substituted temporarily with the charging machine by inserting the charging plug and withdrawing the U links from the two bottom sets of holes.

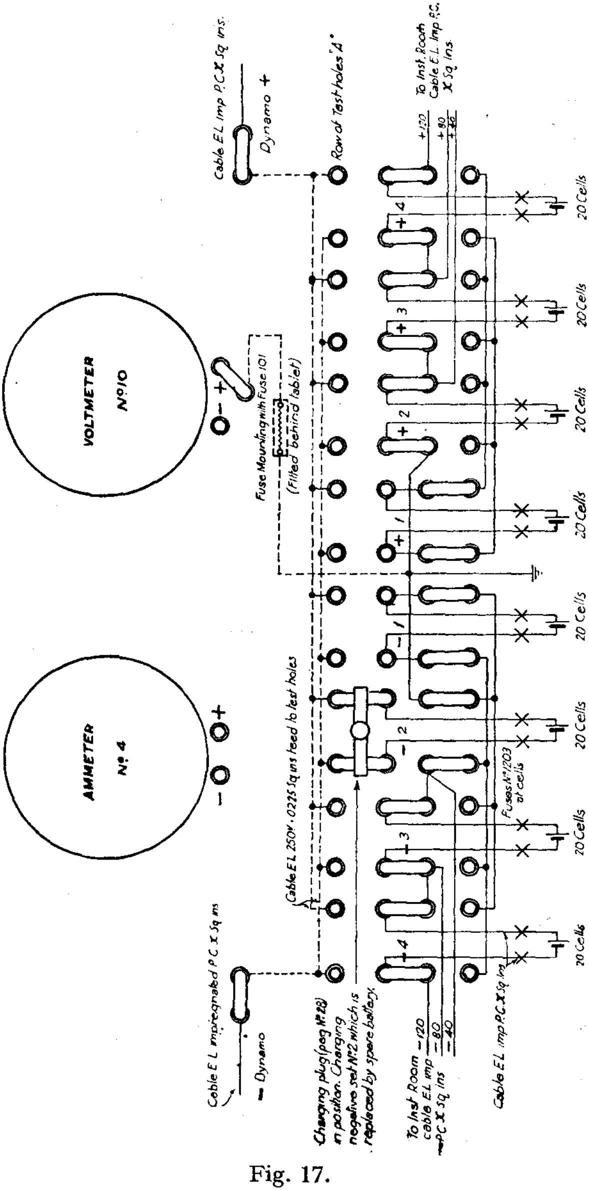
Fig. 16 shows the theoretical connections when (*a*) the 8 and 12 cell sets are being charged in series ; (*b*) when the 12 cell set is being charged separately, and (*c*) when one of the 20 cell sets is under charge.

The 6-volt cabinet is similar to the 8-volt cabinet, except that no 24-volt tap is provided and the auxiliary Test Holes for the telephone tap are not fitted.

It has been found necessary to modify, as indicated in Fig. 17, the arrangements shown in Figs. 13 and 14, in consequence of the introduction of Baudot working at certain small offices at which the power supply is not constant in potential, thus involving the use of the secondary cell installation for the Baudot " drives."

It will be seen that the 8-voltage tablet shown in Fig. 14 has been adapted to provide 6 voltages, the seventh and eighth sets of test holes being utilised to provide for two charging sets, one on the negative side and the other on the positive side. Fig. 17 shows that on the set of test holes accommodating the No. 2 (–) group of 20 cells the U links have been transferred from the centre position to the position beneath, thus connecting the negative " charging " group to the instrument room leads. By the insertion of the charging plug in the upper position of this group of test holes the No. 2 (–) group is connected to the dynamo for re-charging. As a positive group may also at the same time be charged, it will be seen that there are eight groups of cells to be charged two groups at a time ; so that four charging days will completely recharge the whole installation.

Considering one side of the battery and taking the numbers 1, 2, 3, 4 to represent the positions of the cells as indicated on



Cable E.L imp P.C.X Sq ins.
Dynamo +
Row of Test holes 'A'
To Inst. Room Cable E.L. Imp P.C. X Sq ins.
+120
+80
+40
VOLTMETER
No10
Fuse Mounting with Fuse 101
(Fitted behind tablet)
AMMETER
No 4
20 Cells
Fuses No 1203 at cells
Cable E.L 250Y. ·0225 Sq ins feed to test holes
Cable E L impregnated P C X Sq ins
— Dynamo
Charging plug (peg No 28) in position. Charging negative set No 2 which is replaced by spare battery.
To Inst Room cable E.L imp P.C X Sq ins
—120
—80
—40
Cable E.L imp P.C X Sq ins

Fig. 17.

Fig. 17, the following will represent a cycle of charge and discharge, viz. :—

	Mon.	Tues.	Wed.	Thur.
40 volts Instrument Room Leads	2	1	2	2
80 ,, ,, ,, ,,	3	3	1	3
120 ,, ,, ,, ,,	4	4	4	1
charging	1	2	3	4

From the table it will be clear that each group of cells is connected to the output side for three days during the complete cycle of charge and discharge. This period of three days is termed the minimum discharge period, upon which largely depends the ampère-hour capacity of the cells to be used in any given case.

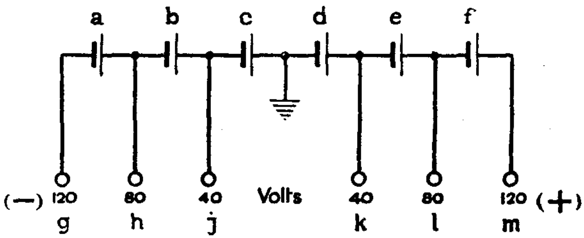


Fig. 18. Instrument Room Leads.

In arriving at the ampère-hour capacity of the cells for this type of board another factor has to be taken into consideration. The arrangement on the output side is represented diagrammatically on Fig. 18. From the wiring diagram it will be seen that, on the output side, the positions of the cell groups *a, b, c, d, e, f* are fixed so that :—

(1) The load on battery *c* is equal to the sum of the loads on *g, h, j* (the instrument room leads) ;
(2) The load on battery *b* is equal to $(g + h)$;
(3) The load on battery *a* is equal to *g* ;
(4) The load on *d* is equal to $(k + l + m)$;
(5) The load on *e* is equal to $(l + m)$;
(6) The load on *f* is equal to *m*.

For the average case the ampère-hour capacities will be in the following ratios, viz. :—

$$a : b : c : : 1 : 2 : 5.$$

The ampère-hour capacity of the two charging groups should be equal to that of batteries *c* and *d*. Generally, battery $c = d$, $b = e$ and $a = f$ as regards ampère-hour capacity, although the output may be different in each case, due to the incidence of the load on the output side.

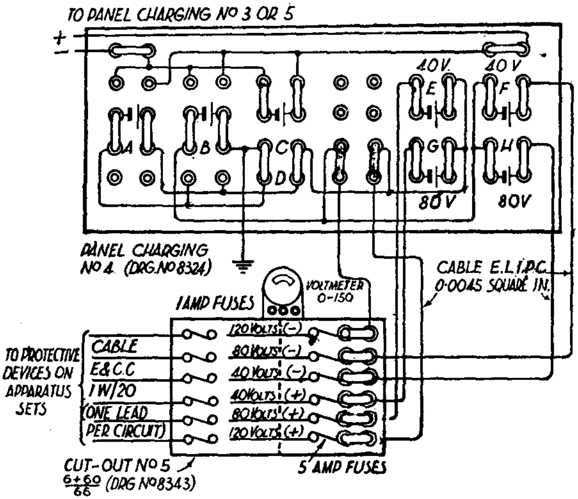


Fig. 19.

Panels, Charging, 3, 4 and 5.—These panels were introduced to meet the conditions in certain small offices at which one Baudot end was terminated.

The principle adopted is that of one main voltage with Counter E.M.F. cells to provide auxiliary voltages.

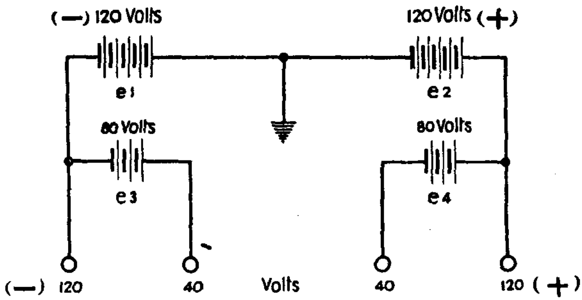


Fig. 20. Instrument Room Leads.

The wiring arrangements are shown on Fig. 19 (Diagram T.G. 396).

Theoretically the Counter E.M.F. principle may be represented as shown in Fig 20.

From the figure it will be seen that the 40 volts (+) Instrument Room lead is equal to $(e_2 - e_4) = 120 - 80 = 40$ volts.

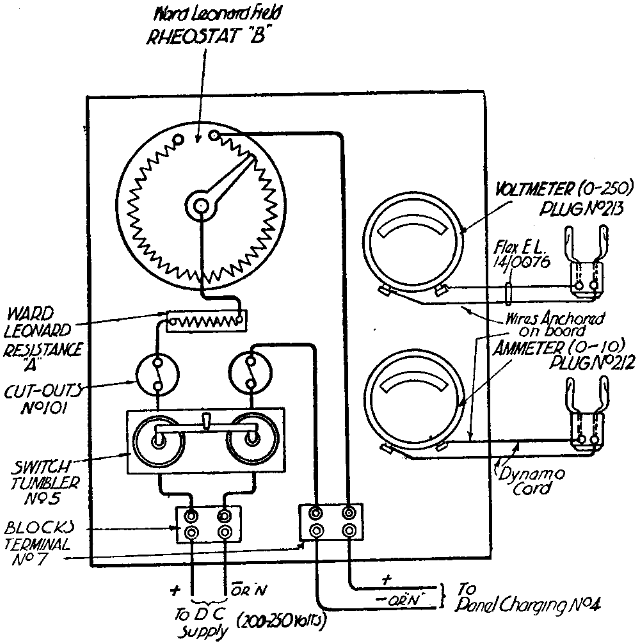
In practice, however, both e_2 and e_4 will vary with the condition of the cells, and the following table is given in order to indicate the best number of Counter E.M.F. cells to join up with the object of ensuring that (1) the voltages on the Instrument Room leads (other than the main voltages) shall not fall much below the nominal figure, and (2) that the variation between the maximum and minimum voltage values shall not fall outside the limits of practical working :—

	Instrument Room Leads.					
	80 Volts.			40 Volts.		
No. of Counter E.M.F. Cells	17	16	15	34	32	30
Max. voltage = a ..	44·2	41·6	39·0	88·4	83·2	78·0
Min. voltage = b ..	32·3	30·4	28·5	64·6	60·8	57·0
$(120 - a)$Effective volts	75·8	78·4	81·0	31·6	36·8	42·0
$(120 - b)$,, ,,	87·7	89·6	91·5	55·4	59·2	63·0

For a variation from a maximum due to the charging voltage of 2·6 volts per cell to a minimum voltage of 1.9 volts per cell the conditions represented by the middle column in each case would be applicable.

Figs. 21 and 22 show the wiring of Panels, Charging, Nos. 3 and 5, which are used in conjunction with Panel, Charging, No. 4 ; Panel, Charging, No. 3, is used where the power supply is direct current between 200 and 250 volts and Panel, Charging, No. 5, with alternating current supply.

The motor generator used in connection with this small office secondary cell installation does not usually exceed the ½ K.W.H. size, this being rendered possible by the fact that the minimum discharge period for the charging tablet arrangement is only two days, thus permitting of the use of secondary



For 8 Ampère-hour Cells	A—Type D 39 ohms	B— ,, FF 22—150 ohms
For 16 ,, ,, ,,	A— ,, D 7·2 ohms	B— ,, FF 24—75 ohms
For 24 ,, ,, ,,	A— ,, D 2·16 ohms	B— ,, FF 26·2—48·5 ohms
For 32 ,, ,, ,,	A— ,, D 1 ohm	B— ,, FF 28—37 ohms

Fig. 21.

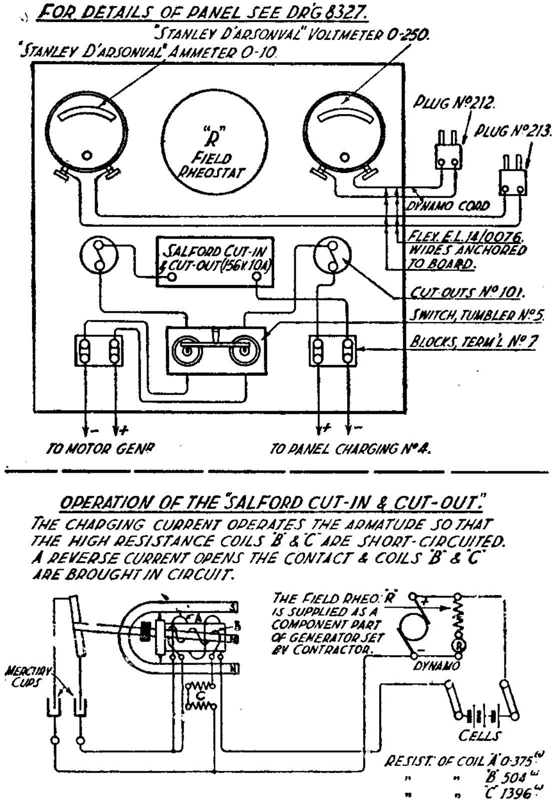

FOR DETAILS OF PANEL SEE DR'G 8327.
"STANLEY D'ARSONVAL" VOLTMETER 0-250.
"STANLEY D'ARSONVAL" AMMETER 0-10.
"R"
FIELD
RHEOSTAT
PLUG N°212.
PLUG N°213.
DYNAMO CORD
FLEX. E.L. 14/0076.
WIRES ANCHORED
TO BOARD.
SALFORD CUT-IN
& CUT-OUT (156V. 10A)
CUT-OUTS N° 101.
SWITCH, TUMBLER N°5.
BLOCKS, TERM'L N° 7
TO MOTOR GEN^R
TO PANEL CHARGING N°4.
OPERATION OF THE "SALFORD CUT-IN & CUT-OUT."
THE CHARGING CURRENT OPERATES THE ARMATURE SO THAT
THE HIGH RESISTANCE COILS "B" & "C" ARE SHORT-CIRCUITED.
A REVERSE CURRENT OPENS THE CONTACT & COILS "B" & "C"
ARE BROUGHT IN CIRCUIT.
THE FIELD RHEO: "R"
IS SUPPLIED AS A
COMPONENT PART
OF GENERATOR SET
BY CONTRACTOR.
DYNAMO
MERCURY
CUPS
CELLS
RESIST. OF COIL "A" 0·375 ω
" " "B" 504 ω
" " "C" 1396 ω

Fig. 22.

cells of small ampère-hour capacity. The generator connections are indicated in Fig. 23.

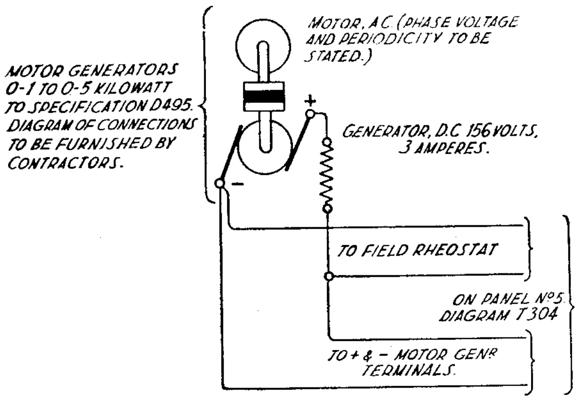


Fig. 23.

A typical case is that of a small office at which there is one quadruple duplex Baudot set together with a small number of local circuits. For this case 24 ampère-hour cells will be sufficient for the load provided the Baudot drives are divided between the 120 volts positive and 120 volts negative main batteries, the arrangements being such that a maximum daily load of about 9 ampère-hours is put on the spacing side of the battery and about 6 ampère-hours on the marking side.

Excluding the Baudot drives such a small office could be efficiently served by the use of 8 ampère-hour cells.

LOOP CIRCUIT BATTERIES.

Universal battery working is not practicable on " loop " circuits and it is, therefore, necessary to provide separate batteries for each of these circuits. For charging and testing purposes these batteries are accommodated on a separate " Secondary Cell Charging Tablet." Associated with this tablet is a secondary cell resistance tablet, on which are mounted four bare wire resistances with adjustable slide rings for regulating the charging voltage.

Each case is treated separately, and the charging and grouping arrangements vary to a considerable extent, as also does the spare battery provision.

In some cases, where a continuous current supply is available, it is found economical to charge direct from the mains,

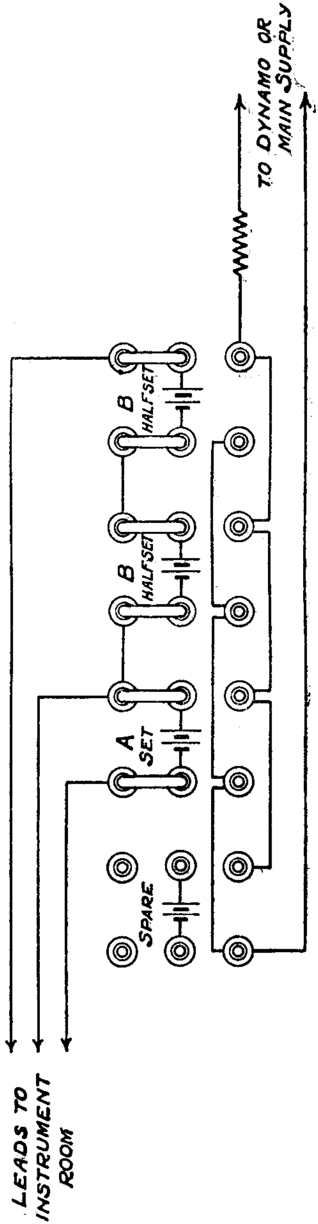

TO DYNAMO OR
MAIN SUPPLY
B
HALF SET
B
HALF SET
A
SET
SPARE
LEADS TO
INSTRUMENT
ROOM

Fig. 24.

while, in others, the charging dynamo for the ordinary secondary cell installation is used, a double pole switch being fitted to connect the dynamo leads alternatively to the secondary cell switch cabinet and to the loop battery tablet.

A typical arrangement is illustrated in Fig. 24, which shows the charge and discharge connections for a quadruplex battery. When a set is to be charged, it is first disconnected from the Instrument Room leads by the withdrawal of the U links and replaced by a spare set, which is connected to the top pair of Test Holes by means of pegs and cords. The set is then connected to the charging Test Holes in the bottom row by means of the two " Links U with Ebonite Handles."

A plug U 212 is used for ammeter tests and a plug U 213 for voltmeter tests.

The Instrument Room leads for loop batteries are taken direct from the charging tablet to the instruments, and it is, therefore, necessary to provide fuses on the Instrument Room tables in addition to the metal-cased or lamp resistances.

The fuses are carried in cut-outs No. 1, which consist of a porcelain base with metal cover, fitted with fuse mountings No. 102, which take glass tube fuses 1/1.

The battery leads to the fuses are taken alternately to the back and the front of the cut-out, so that the battery cannot be short-circuited by the accidental connection of contingous fuse mountings with screwdrivers or other metallic objects.

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