

POST OFFICE ENGINEERING DEPARTMENT

TECHNICAL INSTRUCTIONS, XXV

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AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

PART 14B

RURAL AUTOMATIC EXCHANGES

25/100 LINES, USING UNITS, AUTO, No. 5
INSTALLATION AND MAINTENANCE

*Engineer-in-Chief's Office
General Post Office
London, E.C.1*

March 1930



LONDON :

PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
Adastral House, Kingsway, London, W.C.2 ; 120, George Street, Edinburgh ;
York Street, Manchester ; 1, St. Andrew's Crescent, Cardiff ;
15, Donegall Square West, Belfast ;
or through any Bookseller.

1930.

43-25-14-222

Price 9d. Net.

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AUTOMATIC TELEPHONE EXCHANGE SYSTEMS.

Part 14 B.—Rural Automatic Exchanges, 25/100 Lines, using Units, Auto, No. 5. Installation and Maintenance.

SECTION I.—GENERAL DESCRIPTION.

1. Introduction.—The automatic equipment using “Units, Auto, No. 5” is suitable for use in a telephone exchange situated in a rural area where an exchange with an ultimate capacity of 90 subscribers’ lines will satisfy the requirements. The difficulties in providing continuous service, which are experienced in small rural manual exchanges, are overcome, provided that continuous attention is given in the manual exchange, or at the auto-manual board, to which the junctions from the rural automatic exchange are connected.

The equipment is housed in a small rectangular building which is built on a site whose arbitrary dimensions are 20 feet by 60 feet. A call office kiosk is also generally erected. (See Para. 24.)

The building is usually constructed with hollow walls, a concrete floor and a sloping roof. Its internal dimensions are 14 feet long by 7 feet, 6 inches wide by 8 feet high. A window is fitted at one end and a half-glazed door at the other. No heating, lighting or water supply is provided.

2. Diagrams.—A schedule of the standard diagrams to which reference is made in this Instruction is given in Appendix No. 1. Diagrams are quoted by number only, no suffix letters being indicated. Copies do not accompany this instruction, so that, in the case of new works, it should be verified by reference to the Monthly Lists that the latest issues, as indicated by the suffix letter, of diagrams are being followed.

3. The plant installed in the building consists of the following:—

- (a) “Units, Auto, No. 5.” One to four.
- (b) Main Frame.
- (c) Power Plant, including two 50-volt secondary cell batteries.

The layout of this plant is shown in Exchange Sketch 3732.

A photograph of the “Unit, Auto, No. 5” is shown in Fig. 1. The unit is self-contained, built in the form of a cabinet, and is 6 feet, 3 inches high by 2 feet wide by 1 foot, 3 inches deep. It is provided with double, air-spaced, sheet-iron sides, back and front. This feature, along with the air-spaced walls of the building, obviates the need for any heating arrangements. Each unit houses sufficient apparatus, including ringer and tone generator, to serve a combined total of 25 subscribers’ and junction lines, and a maximum number of four units may be installed in one rural exchange. The junctions from the rural automatic exchange will always terminate at a manual exchange or an auto-manual board. Standard automatic telephones are employed at subscribers’ premises.

4. Facilities provided.—The equipment provides the following standard facilities —

- (a) *Coin Box circuits* may be installed.
- (b) *Automatic metering* on local calls.
- (c) *Supervisory signals* on a junction call in either direction, controlled by the switch hook of the rural automatic exchange subscriber.
- (d) *Number unobtainable tone*.

The following further facilities, some of which are standard facilities in modified form, are provided, viz.,

- (e) *The Busy tone* is of the standard pitch but has a beat of one second tone followed by one half second silence. *Busy flash* is not provided.
- (f) *Ringling current*, which is generated by a 16-cycle vibrator, has a beat of one half second ringling followed by one second silence.
- (g) *Ringling tone* is supplied from the ringling vibrator and has the same beat as the ringling current.
- (h) *Metering*. Automatic metering, although provided on local calls, does not take place on junction calls.
- (j) *Forced release* is applied to selectors held by abnormal conditions for longer than a given period.

5. The following standard facilities are omitted in the interests of simplification, viz. :—

- (a) Dialling tone is not provided.
- (b) No provision is made for party lines, junctions with omnibus working, auxiliary P.B.X. lines (but see Para. 73) or Earth return circuits.
- (c) No special "trunk barred" indication is given on calls to the manual exchange.
- (d) The operator hold condition does not exist.
- (e) No trunk offering circuits are provided.
- (f) Junctions outgoing from and incoming to the rural automatic exchange cannot terminate on automatic selectors at the distant exchange: they must terminate on manual positions. The reason for this with regard to outgoing junctions is that a selector in the rural automatic exchange cannot repeat impulses forward. The reasons with regard to incoming junctions are of a service nature, *e.g.*, non-standard tones being employed at the rural automatic exchange and a special dialling number being required at the distant automatic exchange.

6. The trunking scheme is shown in Fig. 2. All calls—junction and local—are effected by the dialling of two digits; the connections for both subscribers' and junction calls are made by means of Connecting Links, four of which are fitted in each unit. Each connecting link consists of a Line Finder, which is a non-homing rotary line switch, and a two-motion selector of the Strowger type. An Assignment Switch allocates the connecting links consecutively as calls are originated.

The subscribers' and junction lines are connected to the banks of the line finders and are also multiplied on the banks of the selectors. When a call is originated, the line finder of the connecting link, which has been seized for the purpose of effecting the call, is brought into operation and its wipers are rotated until they reach the bank contacts associated with the calling line, on which they come to rest. The selector of the connecting link is then connected *via* the line finder to the calling line, and receives the two trains of impulses from the calling subscriber's dial. The selector steps its wipers to the bank contacts of the number dialled; ringing current is then automatically applied and is cut off when the called subscriber answers. Metering takes place on local calls when the called subscriber removes the receiver.

All apparatus is restored to normal when the calling subscriber replaces the receiver.

7. Numbering Scheme.—Levels 1 to 9 of the selectors are used for subscribers' lines. When an exchange, consisting of one unit, is opened, the subscribers' numbers commence on level 2 and, as units are added, continue to level 9, level 1 being the last level to be brought into service. Level 0 is reserved for junctions.

Junctions to more than one exchange may be provided. If there is only one group of outgoing junctions, the number dialled is 01. If there are two groups, the second is called by dialling, say, 05.

The total number of outgoing-junction terminations cannot exceed ten. Since junctions to more than one exchange may be provided, several small groups of junctions may be accommodated, each group being terminated on a group of consecutive bank contacts. When the second digit of the junction number has been dialled, and if the first junction to the required exchange is engaged, an automatic-stepping circuit is brought into use on the 0 level, thereby causing the selector wipers to step on quite independently of any dialling. The automatic stepping continues as long as the selector wipers encounter busy junctions until the wipers are stepped to the bank contacts of the last line to the required exchange. If this is engaged, busy tone is returned to the calling subscriber.

Both junction and subscribers' lines are equipped with similar calling apparatus so that the operation of the apparatus on an incoming junction call is the same as that in the case of a subscriber's call.

8. Parent Exchange.—Where the rural automatic exchange has junctions to only one manual exchange, that exchange is known as the Parent Exchange. Where the rural exchange has junctions to more than one manual exchange, the exchange which deals with the indirect junction traffic is the Parent Exchange.

9. Inter-Exchange Working.—Two rural automatic exchanges cannot work directly to each other, but one manual exchange may gain access to another *via* a rural automatic exchange as shown in Fig. 2.

10. Local Call and Incoming Junction Call.—The calling subscriber lifts the receiver, or the manual operator plugs into a junction circuit, and dials the required subscriber's number, which consists of two digits. Ringing tone is heard by the calling subscriber during the period that ringing current is applied to the called subscriber's line. If the required line is engaged, busy tone is returned to the caller, and if a spare number has been dialled, number unobtainable tone is received by the caller. The ringing current and ringing tone are cut off during the first silent period after the called subscriber removes the receiver. After conversation, the release of all apparatus is effected when the calling subscriber replaces the receiver or the calling operator removes the plug from the junction jack.

11. Outgoing Junction Call.—The groups of lines to distant exchanges are allotted certain bank contacts on the 0 level of the selectors, as explained in Para. 7. Consequently, a calling subscriber, requiring a junction call, dials the digit 0 and one other digit, the latter depending upon the exchange required. The second digit steps the selector wipers to the first outlet to the required exchange and the selector connects to the outlet or hunts and connects to the first free outlet. Upon the seizure of a free outlet, ringing current is sent to the distant exchange, thereby operating a calling signal, and ringing tone is transmitted to the calling subscriber.

When the calling subscriber replaces the receiver, the apparatus at the rural automatic exchange returns to normal and gives a clear to the manual exchange.

12. Coin Box Calls.—Coin boxes of the prepayment type are used, and a local call is effected in the usual way without the assistance of a manual operator. On outgoing junction calls, a discriminating feature is provided whereby the operator at the parent or other manual exchange receives a tone, on the depression of a key associated with the junction, when a call is received from a coin box line.

13. Overflow Meter.—If the four connecting links of a unit are engaged, a fifth caller causes the overflow meter to be operated once on the removal of the receiver. One overflow meter is provided on each unit and registers once for every occasion upon which more than four subscribers are calling in the unit.

14. Apparatus common to each Unit.—The assignment switch consists of a non-homing rotary line switch equipped with four banks, only three of which are used. Associated with it are four relays and one overflow meter. Connections from the four connecting links are multiplied from bank contacts 2 to 25 on the switch, the meter being connected to bank contact 1. Normally the wipers rest on the bank contacts of a free connecting link. When a subscriber removes the receiver, the connecting link, on whose bank contacts the wipers rest, is seized and the assignment switch then steps to the bank contacts of the next free connecting link. If all links are engaged, the switch steps to bank contact 1. Should another subscriber call while this condition persists, the overflow meter operates as stated in Para. 13.

15. Apparatus common to the Exchange is divided into two sets, each of which is assembled on a separate base plate provided with a cover and is capable of ready replacement by being provided with the jacking-in feature. The two sets are shown in the front view of the unit in the photograph illustrated in Fig. 1. In exchanges with one unit only, the common apparatus is mounted on the unit. Where two or more units are fitted, the common apparatus is provided on both the first and second unit, that on the first unit being the working apparatus and that on the second being the stand-by apparatus.

The following paragraphs describe the main features and functions of the common apparatus.

16. The Relay Timing Group is a group of six relays, three of which are so connected that each operates in turn. The first re-operates when the third releases, so that a cycle of operations is produced which continues as long as the circuit is completed. The relays control three auxiliary relays and these, in turn, control the operation of the ringing current, ringing tone, busy tone, and a Time Delay Switch. Each of the auxiliary relays is operated for approximately one half second and released for one second.

17. Ringing Current is generated by means of a vibrator associated with a transformer. One of the auxiliary relays of the relay timing group completes the circuit of the vibrator coil, which attracts and holds a bob attached to one end of a flat steel spring, the other end of which is fixed. When the relay releases, the bob is released and the spring causes it to vibrate mechanically between two contacts, which are so arranged that direct current is connected alternately in each of two primary windings of the transformer; by this means alternating (ringing) current is produced in the secondary winding. The vibrations continue until the relay timing group causes the bob to be again attracted. The cycle of operations continues and ringing current is generated for one second with intervals of one half second during which no current is generated. The ringing current is supplied to half the selectors in the exchange for one half second, and to the other half for the remaining half second of its duration. Thus, the interrupted ringing current sent out from the selectors to subscribers' lines consists of a ringing period of one half second followed by a silent period of one second.

18. Tones.—Tone current is generated by a special, differentially-wound, buzzing relay. When its circuit is completed, the relay operates and opens its contacts; these open a short-circuit on the second winding which, being differential, causes the relay to release. The second winding is thereby again short-circuited and the relay re-operates. The cycle of operations recurs rapidly and a tone current of about 400 p.p.s. is produced. The tone current is used without interruption for the number unobtainable tone and the coin box discrimination tone and, when interrupted by one of the auxiliary relays of the relay timing group so to provide a one second tone period followed by a period of one-half second silence, forms the busy tone.

19. The Time Delay Switch applies a forced release to any connecting link, which has been held by abnormal conditions for longer than a given period, and restores the connecting link for general service. It consists of a rotary line switch which is stepped by means of the relay timing group once in every 1.5 seconds. It is brought into operation on every call and is disconnected when the second digit is received. By means of straps on a small tag-block, the delay period may be so varied that the forced release may be applied after an interval of from 12 to 25 seconds—the lower and upper limits of the shortest period—or from 30 to 60 seconds, the lower and upper limits of the longest period. Should a subscriber fail to dial the two digits within the specified period, or leave the receiver off without making a call or after the called subscriber has cleared, or if any faulty condition arises on any line which causes a selector to be seized, the forced release is applied. After the selector is released, the line is connected to a high resistance relay and the receiver must be replaced or the fault cleared before access to a connecting link can be regained.

20. The Fault Test Circuit provides means whereby an operator at a distant manual exchange may ascertain whether certain faults exist at the rural automatic exchange. The operator dials a given number and hears ringing tone in the ratio of one second tone, one-half second silence, if:—

- (i) the ringing apparatus is working correctly,
- (ii) there are no blown fuses,
- (iii) all the selectors have released correctly (not including selectors engaged while the test is made); and
- (iv) the battery charging equipment has not failed.

If the ringing apparatus is failing, no tone is heard. Number unobtainable tone is heard if a fuse is blown, a selector shaft has failed to restore to the normal position, or the charging plant has failed.

21. Means of Cross Connection.—The wiring from the line finder banks terminates on a connection block—the Subs. Equipment Block—which is mounted in the upper part of the unit; the wiring of the selector banks terminates on four blocks—the Selector Multiple Blocks—which are mounted beneath the subs. equipment block. A jumper field is arranged between the subs. equipment block and the selector multiple blocks, by means of which any line equipment may be connected to any subscriber or junction.

22. The Main Distribution Frame is fitted on the left of the first unit, the upper half accommodating the protectors and the lower half the fuses; the protectors and fuses are mounted on the same side. The former are cabled to

the selector multiple blocks of the first unit, and the external leading-in cables terminate on the fuses.

A cable for junctions only is provided between the main frame and the first unit, and enables incoming junctions to be independent of the selector multiple. Outgoing and incoming junctions may be provided under certain conditions.

SECTION II.—INSTALLATION OF EQUIPMENT.

23. Introduction.—The section deals with the installation of equipment and covers the work necessary in connexion with the Rural Automatic Exchange, Parent Exchange Terminations, Subscribers' Apparatus and Coin Box lines.

24. Kiosk.—For the Call Office, which is usually provided on the Exchange site but may be located at some other convenient point as determined in special cases, a "Kiosk, No. 3" should be fitted. Instructions as to the assembly are given in Mimeo Circular "Kiosk No. 3," 5th February, 1929. When fitted on the Exchange site, the kiosk door should open directly on to the road.

No lighting is provided in the kiosks at rural automatic exchanges.

25. External Plant.—The line work and the leading-in of the external cables should be in accordance with T.I. XXI. as already applied to small manual exchanges.

The position of the distributing pole should be such that it is unobtrusive and does not detract from the amenities of the surroundings. It is recognized that it is not possible to make hard and fast rules, but normally it should be practicable—with a slight increase in the length of the lead-in cable—to place the pole on the site at the extreme left-hand side when viewed from the road. The placing of the pole in the front of the building should be avoided.

26. Impulsing Limits.—The internal equipment is designed to work to the following impulsing limits, which apply to both subscribers' and junction circuits :—

- (a) 1,200 ohms loop resistance (exclusive of all equipment).
- (b) 20,000 ohms leak on either line.
- (c) 20,000 ohms low insulation between positive and negative lines.
- (d) Dial range, 7 to 14 impulses per second.
- (e) Voltage range, 46—52 volts.

27. Apparatus required.—Appendixes II and III show the main items required for Exchange Plant: Subscribers' apparatus is not included. *Requisitions should be forwarded immediately after possession of the site has been obtained to ensure that all apparatus is available when the building is completed.* Requisitions for the Earth plate and wire, however, should be forwarded as soon as building tenders are invited, to ensure availability for use as indicated in Para. 28.

The approximate overall dimensions of a "Unit, Auto, No. 5" are 6 feet 3 inches high by 2 feet wide by 1 foot 3 inches deep. The weight is 370 lb. nett.

The dimensions and weight of the Main Frame are given in the Rate Book, and similar particulars of the Power Plant items may be obtained from T.I. XXIV, Para. 54.

28. Earth Plate.—The Earth plate and wire should be fitted in accordance with T.I. XVIII, except where those instructions are modified by the clause entitled "Drain" in the "Specification and Conditions of Contract" for the building (see Part 14A) and further as follows :—

The Earth wire should be "Wire, Copper, Soft, 3/20 strand." It should be continued underground from the soak-away to enter the building by way of the joint box and lead-in pipe or by way of the hole provided for the exhaust pipe from the petrol engine. The method will depend on the position of the soak-away. Entry for the wire by means of the joint box and lead-in pipe is to be preferred, as this method enables the wire to be connected to the main frame by the most direct route with a minimum of internal wiring. The portion of the wire laid underground should be protected from any subsequent digging operations by rough wooden boards placed over the wire.

29. Drying of Building.—Installation of the automatic unit should not be put in hand until the premises are reasonably dry, and, to achieve this end during the winter months, arrangements should be made to dry out the premises by brasiers or other suitable means. The arrangements, however, should not delay the installation of the other portions of the equipment.

30. Interior Painting.—Owing to damp walls or other circumstances, it is usually not possible to arrange for internal decoration at the outset and this matter should be given attention after installation of the equipment is completed and when the walls are thoroughly dry. Any damage should then be made good and the walls painted with two coats of Walpamur Duradio, light stone colour.

When the installation is completed, the floor should be covered with linoleum (see Appendix No. II, Item 11).

31. Protection of Path.—Care should be taken to protect the path by planks or other suitable means during the period of installation. The "Unit, Auto, No. 5" must be handled carefully when being taken into the building. Rollers should not be used because of damage to the sheet iron case and, possibly, to the equipment. The best method is to employ a number of slings made of strong webbing and provided with round wooden handles, thus enabling the unit to be carried upon its side in a convenient manner.

32. Heat for Soldering Irons.—For the purpose of heating soldering irons during installation, a blow-lamp may be used. The lamp should be located just outside the door and protected from wind by bricks or sheet iron. If it is essential that the blow-lamp should be used inside the building in connexion with cable lugs, etc., the usual fire precautions must be observed.

33. The type of battery-charging set depends upon the public power supply available (see T.I. XXIV, Para. 18). Where a public electric supply is not available, a Petrol Engine Battery-Charging Set should be employed.

If possible, the power plant should be erected prior to the delivery of the "Unit, Auto, No. 5." Cabling details are indicated on the power plant circuit diagram quoted in Appendix I.

The position of the power board ("Panel, Charging, No. 20") is shown on Exchange Sketch 3732. The panel should be screwed to the floor, and anchored to the angle iron fitted on the wall by means of the length of $\frac{1}{4}$ -inch flat iron which is provided. The latter should be bolted to the back of the right-hand iron upright (face view) at the top and carried vertically to a height of 6 feet 3 inches. A right-angled bend is provided to bridge across the 1-foot, 10-inch gap to the angle iron on the wall, to which the flat iron should be bolted.

34. Petrol Engine Charging Set.—The position of the Petrol Engine battery-charging set is shown in Exchange Sketch 3732. The erection of the engine should proceed as follows:—

Diagrams Misc. 3056 and 3057 refer. Place the wall box in the wall and cement in exactly to dimensions, the inner face to be vertical and square with the wall, the oval flange facings being on the right. Screw the exhaust pipe and bend into the wall box from the outside with the flanged end downwards and connect to the silencer. Grout under the silencer to support it. Fit the vertical pipe with the return bend at the top, set vertical and cement the stay into the wall.

Screw the air-filter pipe into the wall box, so that the gauze-covered pipe hangs downward.

Thread the four holding-down bolts through the wooden engine base and place the base roughly in position over the four holes in the floor.

Place the generating set in position, and connect up the exhaust pipe from the expansion chamber on the engine to the lower flange in the wall box, moving the set and its base until the pipe lines up and can be tightened at both ends. See that the base is square with the building and grout in the bolts; the holes in the floor extend a little beyond each end to facilitate this operation.

Do not tighten the bolts until after three days if Portland Cement is used or one day if quick-setting cement is used.

Connect up the air inlet of the carburetter to the upper flange of the wall box by a flexible tube; at least $\frac{3}{8}$ inch of thread must be visible between the elbow and the air-adjusting sleeve of the carburetter.

Fix the petrol tank cupboard outside the building. The lower left-hand corner overlaps the right-hand corner of the wall box by 2 inches.

Pass the petrol pipe from inside the building, through the upper left tapped hole in the wall box, fixing it by means of the screw nipple and collar. See that the coil in the pipe is horizontal, and *not on edge*. The outer end of the pipe must pass through the lower hole in the corner of the cupboard and be connected to the petrol cock on the tank.

Pass the petrol drain pipe through the lower left hole in the wall box, and connect it to the drip tray. See that the pipe falls evenly from the tray to the wall box and through the latter, so that any overflow discharges freely to the ground.

The leads to the petrol valve relay pass through the tube in the upper left corner of the wall box.

Connect the water pipes and so place the tank that the pipes are not strained.

Screw the 1-inch bend into the vent hole in the tank, pass the pipe from outside, through the hole in the wall, and screw it into the bend. Cement the pipe into the wall but shake the pipe slightly before the cement has set, so that the pipe is not solidly held.

The galvanised iron box containing the petrol tank and the exhaust box and fittings should be painted the same colour as the external walls of the building.

35. Tungar Rectifier or Dynamotor.—Where a Tungar Rectifier or Dynamotor is used, the set should be placed on a “Stool, No. 2” located under the panel of the power board (see Appendix III, Schedules 2 and 3).

The public electric supply meter should be fixed adjacent to the “Panel Charging, No. 20” and the “Box, Service, E.L. No. 1,” and the starting switch, when used, should be fitted on the strips provided immediately under the panel. The main supply leads to the D.P. switch and machine should be “Cable, E.L., I.R.V. Core, 250 volt, single, .01 square inch.”

36. Power Cables and Batteries.—The cables from the “Panel, Charging, No. 20” to the battery and generator should be run in casing fixed to the walls (Diagrams A.T. 2018/19/20).

Cables marked H and L should be run together in the same casing 3 feet 3 inches from the floor. Cables marked J and M should be run together in another casing 4 feet from the floor. The generator cables marked K and O should be run together in a further casing 2 feet 6 inches from the floor. Where a Dynamotor or Tungar Rectifier is used, Cables K and O should be suitably shortened and taken direct to the charging machine. The 9-inch space between the pairs is required to minimize inductive effects. Cables G and P should be run together over the main frame to the negative and positive bus bars of the first “Unit, Auto, No. 5.”

The arrangement of the cells on the battery rack should be in accordance with Diagrams A.T. 2018/19/20 and the erection of the cells in accordance with the method laid down in T.I. XXIV.

The power plant should be tested in accordance with T.I. XXIV, Section IV.

37. Operation of the Petrol Set.—Instructions and notices regarding operation when a petrol engine charging set is installed will be found in Appendix III, Schedule 4.

It will be seen that, in a petrol-electric set, the engine is stopped by the operation of a petrol valve (Diagram A.T. 2018). Stopping by means of a short-circuit across the primary of the magneto is shown on Diagram A.T. 2022, but this feature should not be wired.

38. Lacquering of power panel switches and protectors.—To avoid corrosion on the power panel switches and the main frame protector springs and fuse posts, the following procedure should be carried out *immediately* upon completion of installation:—

Polish the switches, switch springs and bright metal parts on the power panel with metal polish and then carefully apply a lacquer known as Transparent Brushing Robbialoid in accordance with the maker's directions. The lacquer must not be applied to the actual rubbing surfaces of the switches, these parts being lightly smeared with a vaselined rag when the lacquer is *quite dry*. (See *Note* overleaf.)

Polish the outer surfaces only of the outer springs of the protectors and apply the lacquer to them, care being taken to see that no polish or lacquer touches the heat coils or spring contacts.

Tighten all the screws on the fuse mountings and apply the lacquer to the ends of the fuses and terminal posts.

The lacquer should be applied with a soft brush of the type provided in cheap water colour painting outfits. Only a small amount of lacquer is necessary and a small tin of it such as is used for cycle lacquering should suffice. If Brushing Robbialoid is unobtainable locally, any other reliable brand of transparent *celluloid* lacquer may be used.

Note.—The foregoing procedure should be carried out immediately at exchanges already installed or in progress. Future supplies of the power panel will be lacquered by the makers and the main frame protectors and fuses only will require lacquering.

AUTO EQUIPMENT.

39. Datum Line.—For the purpose of determining the position of the auto equipment, a datum line should be drawn parallel to the length of the building and bisecting the cable chase.

40. Position of the Main Frame.—The main frame is shown in Diagram E.C. 1231. It should be placed over the end of the cable chase as indicated in Exchange Sketch 3732. The apparatus side should face the batteries, and the rectangle formed by the inner edges of the base should coincide with the edges of the cable chase.

The frame should be fixed to the floor by means of four 2½-inch by 10 iron, countersunk, wood screws and four "Plugs (Rawlplug) No. 18, 2 inch," and should be strapped to the angle iron already fitted to the wall by means of a length of 1-inch by ¼-inch iron bolted to the right vertical of the frame at a height of 6 feet 3 inches. "Fuse Mountings, No. 4002," "Protectors, H.C. and Test, 40 B," and "Strips, Fanning, 40 line," as shown in Diagram E.C. 1231, should be fitted as the requirements of the Exchange demand. (See also notes on Diagram E.C. 1341). The protectors should be lacquered as described in Para. 38.

41. Position of the "Units, Auto, No. 5."—The first unit should be placed in position with its front (*i.e.* the apparatus side) facing the battery rack, the front edge of the base of the unit being 9 inches from the datum line which runs beneath the unit. The left-hand side of the unit should be as near as is practicable to the right-hand side of the main frame. The second, third, and fourth units should be lined up close to the right of the first. There should be a distance of 2 feet 2 inches between the rear of the units and the wall.

The units should be strapped together by lengths of 1-inch by ½-inch iron about 2 feet long. A bolt for the purpose will be found in the centre at the top of the unit. The first unit should also be strapped to the right-hand vertical member of the main frame with 1-inch by ½-inch iron.

Every unit should also be strapped to the angle iron in the wall, by means of 1-inch by ¼-inch iron secured to the same bolt in the centre of the unit.

The iron straps should be painted grey, similar to the unit.

CABLING.

42. Main Frame.—The cabling of the main frame should be in accordance with Diagram E.C. 1341. "Cable, E.S. & W. Core, Twin, 50 pr/10, 25 pr/10, and 10 pr/10" should be used between the main frame and the automatic units, and an appropriate size of the same type of cable should also be used for the lead-in from the cable chase.

The external cable should be led up the right-hand vertical and taken across to the left-hand vertical at the level of the lowest fuse mounting. This arrangement is necessary in order that the small cover under the frame may be withdrawn by sliding it towards the wall.

The cable should be stripped, laced and wired in accordance with standard practice laid down in T.I.I.

The cabling from the protectors should be so arranged that the lead covering of each cable is stripped at the butt of the form just below the bar of the frame to which the cable should be tied. The forms themselves must not be tied to the frame or to adjacent cables. The protectors should be wired in accordance with Diagram E.C. 1272.

The Earth wire from the cable pit should be brought up the right-hand side of the frame, through the Earth lugs, and a branch taken from the bottom lugs across and up the other vertical in such a manner that the jumpering is not affected. The wire should be soldered at each lug, and the Earth wire to the power board soldered into one of the top lugs together with the Earth wire from the cable chase.

43. "Units, Auto, No. 5."—The cabling should be provided in accordance with Diagram E.C. 1341.

The cables from the main frame or a preceding unit should enter a unit by the left-hand cable hole and should be stripped so that about ½ inch of the lead

covering projects into the unit. All wires, except those of the miscellaneous cable, should be laced together in one form and distributed to the multiple and junction blocks as shown in Diagram E.C. 1345. The forms of the individual multiple blocks should be tied to the multiple forms from the selector banks.

The outgoing wires and power cables should also be arranged as shown in the above diagram. The individual multiple forms should be kept at least 1 inch from the fanning strip, and the wires should be soldered in the tag slots nearest to the ebonite.

When all the cabling has been installed, the wood blocks which covered the cable holes in the roof of the unit should be cut into two parts, each part being arranged to fit the cables, thus ensuring a minimum air space between the cables and the wood. Any spaces between and around the cables should be neatly filled with "Compound, No. 5" to make the unit air-tight.

ALLOCATION AND CONNECTION OF CIRCUITS.

44. Subscribers' Lines.—The numbering of subscribers should normally, commence at 20 and continue in accordance with the numbering of the main frame protectors (see Diagram E.C. 1341), circuits 10 to 19 being the last to be brought into use. Should deviations from this course be desired, arrangements should be made locally with the District Manager.

It will be noted that, with an installation comprising one automatic unit only, the subscribers' multiple cable between the M.D.F. and the multiple block on the unit allows numbers between 20 and 45, with the exception of 40, to be allocated. When a second unit is added, the increase in cabling allows for any number between 20 and 69. Similarly for an exchange having three units, the numbering scheme is 20 to 95, with the exception of 90. When the equipment reaches the maximum of four units, the numbering scheme is 20 to 99 and, if necessary, the numbers 10 to 19 are available for use.

45. Junctions.—The junctions to the Parent Exchange should invariably commence at 01. The calling equipments should be so allotted to the junctions that no two junctions are dependent upon the same calling equipment fuse. In exchanges having more than one unit, the junction calling equipments should be distributed equally among the units. In exchanges which have junctions to more than one distant exchange, the numbers, allotted to the first line of each group of junctions to exchanges other than the parent exchange, should be arranged locally with the District Manager.

The "P" (private) tags of all the junctions except the last in a group should be strapped to the corresponding "P 1" tags. The connections should be made on the multiple block of the unit in which the circuits are jumpered.

The chart in each unit showing the allocation of calling equipments should be completed in pencil, thus allowing changes to be easily recorded.

46. Coin Box Circuits.—Subject to the conditions in Para. 44, any convenient multiple number and calling equipment may be allotted to a coin box line.

The following modification should be made on the line block in respect of each coin box circuit:—The Earth common, looped along the "CB" row of tags on the line block, should be unsoldered from the tag of the circuit which is to be used for the coin box line. The common should be bridged over the tag so that contact with it is prevented. The tag should then be connected by a length of "Wire, Switchboard, 9¼" to the connection plate marked "CB" on the side of the line block.

47. Fault Test Number.—For the purpose of enabling the parent exchange operator to ascertain whether certain faults exist, multiple number 99 should be connected in the following manner. The positive tag of circuit 99 on the first unit should be jumpered to the connection plate marked "T.N." on the line block, no connections being made to the negative or private tags.

The wire shown on Diagrams AT. 2018, 2019 and 2020 from terminal "F" of the "Panel, Charging, No. 20" to the "alarm tag, miscellaneous connection block," should be connected to tag 30 on the miscellaneous block on the first unit.

48. Spare Numbers.—The positive tags of all spare circuits should be strapped to the corresponding number unobtainable tone tags. The connexions should be made on the multiple blocks in the first unit.

49. Straps on the Miscellaneous Block.—It is necessary to fit straps between the tags on the “Miscellaneous” block to bring the common apparatus such as ringing, tones, time delay switch, etc., into use. These tags are arranged horizontally in four rows which may be referred to as Nos. 1, 2, 3, and 4, commencing from the top. Straps should be fitted between tags Nos. 1 and 2, and between 3 and 4.

50. Jumpers.—Jumpers on the main frame should be run in accordance with Diagrams E.C. 1231 and E.C. 1272, “Wire, E. & F.P., 1 pr. 12½” being employed.

Jumpers inside the units should be run in accordance with Diagram E.C. 1341, “Wire, Switchboard, 3-wire/9¼” being used.

The heat coils should be removed from the protectors of the circuits to which jumpers are connected, until it is desired to bring the automatic equipment into use.

51. Artificial Lighting.—In regard to the general lighting of the exchange, only a bare sufficiency of light, to enable the maintenance officer to see his way about and to carry out general duties, should be provided. Illumination for adjusting apparatus should be obtained by means of a headgear lamp operated from the main battery, *vide* Section III, Para. 126, but the main battery must not be used to provide general lighting.

The general lighting should comprise two small lamps, of pocket flash-lamp type, accommodated in suitable holders with reflectors, each fitted on the roof joists approximately midway between the face of the units and the battery rack. The first lamp should be located 4 feet 6 inches and the second 10 feet 6 inches from the door. The first should be controlled by a switch on the wall immediately inside the door at the right-hand side, while the control switch for the second should be fitted on the wall midway between the petrol engine set and tank.

The two circuits should be wired with “Cable, E. & F.P., 1 pr/10” and each supplied separately from two “Cells, Dry, Z” joined in series with a 2-ohm resistance provided by connecting two “Spools, Resistance, No. 1—4 ohms” in parallel. It should not be necessary to provide a mounting for the spools; they may conveniently be located near the two dry cells—say, held between them. It is not necessary to run wooden casing; the wire should be stapled to the walls and roof joists. A list of apparatus required is included in Appendix II, Item 19.

TESTING.

52. For general testing on subscribers’ and junction lines, a “Case, Test, D 9262” (Diagram A.T. 67) is required. A suitable backboard should be fixed to the end of the main frame at right-angles to the face of the power board. The test case should be fitted on the backboard so that the top of the case is approximately 4 feet from the floor level. The actual method of fixing the backboard by means of iron straps should be determined locally. The “Telephone, No. 121,” should be fitted immediately above the test case.

A detector and dial-speed tester are needed on the test case during the installation stage, but should be recovered when the exchange is working. Under maintenance conditions the items should be fitted temporarily as required.

53. Test of Multiple.—The usual tests for continuity, reversals, etc. should be made on the cabling between the M.D.F. and the first unit, and on the cabling between units.

54. Test of Auto Apparatus.—“Unit, Auto, No. 5” is thoroughly tested out at the Contractors’ works before delivery and, therefore, only working tests are necessary during installation.

Typical tests are given below and these may be carried out by using the “Tester, No. 82” (Diagram A.T. 2035) for simulating calling and called subscriber or manual board operator conditions as required. The tests should be carried out when the installation is completed and just prior to placing the exchange in service.

In the following tests the outgoing and incoming sides of the auto. equipment test box are referred to as test circuits Nos. 1 and 2 respectively. Multiple numbers 96 and 97 on the first unit should be connected with three-way jumpers to the first and second circuits on the line block, and test circuits Nos. 1 and 2 connected by means of the clips to multiple numbers 96 and 97. If there is more than one unit, the above connections are required on each.

55. Test 1. Regular Local Call.—Throw key 4 in test circuit No. 1 to the “1,200-ohm loop” position, key 3 in test circuit No. 2 to the “connect” position, and dial 97. Check that the selector action is smooth. Ringing tone should be heard in the watch receiver when key 5 is thrown to the “listen” position, and the bell in No. 2 test circuit should ring satisfactorily. Trip the ringing by throwing key 2, and observe that the meter associated with No. 1 subscriber's equipment operates once. Throw key 3 to the “transmission” position and listen for the buzzer in the watch receiver. Restore the keys on the test circuits and check the correct release of the selector. Carry out this test on every selector in each unit.

56. Test 2. Local Call. Called Line Busy.—Operate key 2, throw key 3 to the “connect” position, key 4 to the “1,200-ohm loop” position and dial 97. Throw key 5 to the “listen” position and check the receipt of busy tone. Restore all keys to normal and note that the meter of No. 1 test circuit does not operate.

Repeat the test on every selector in each unit.

57. Test 3. Receipt of N.U.Tone.—Throw key 4 to the “1,200-ohm loop” position and dial any spare number. Verify receipt of number unobtainable tone by throwing key 5 and listening on the receiver. Restore all keys to normal and note that the meter associated with No. 1 test circuit does not operate.

Repeat the test on every selector in each unit.

58. Test 4. Junction Call. Last Outlet Free.—Strap the P and P1 multiple tags of each circuit from 01 to 09 and connect them to Earth. Connect No. 2 test circuit to multiple number 00 and throw key 3 to the “connect” position. Throw key 4 to the “1,200-ohm loop” position and dial 01. Check that the selector hunts smoothly over circuits 01 to 09, stopping on 00. The bell of No. 2 test circuit should ring. Throw key 2 to trip the ringing, and then test for reversal in the direction of the current in No. 1 test circuit by means of a detector. Restore all keys to normal and note that the meter on No. 1 test circuit has not operated.

Repeat the test on every selector in each unit.

59. Test 5. Junction Call. All outlets Busy. The conditions are the same as those of Test 4, with the exception that the P contact of 00 should be earthed. The P and P1 contacts of 00 should not be strapped. Dial 01 on test circuit No. 1 as before, check the receipt of busy tone by listening in the receiver with key 5 thrown, and see that the meter on the subscriber's circuit associated with test circuit No. 1 does not operate.

Repeat the test on every selector in each unit.

60. Test 6. Forced Release under Called Subscriber Held Conditions.—Reconnect No. 2 test circuit to 97. Throw key 4 to the “1,200-ohm loop” position, key 3 to the “connect” position and dial 97. Trip the ringing by throwing key 2 and then restore key 2. The time delay switch should operate, and, after a period of from 15 to 30 seconds, the selector should release. Restore all keys to normal.

Repeat the test on every selector in each unit.

61. Test 7. Forced step-on feature of the Line Finder when Earth is disconnected from Line Finder Bank P1.—Set all line finders to No. 3 bank contact. Insulate the L1 resting contact on the subscriber's equipment associated with No. 1 test circuit to simulate a faulty circuit. Operate key 2 and throw key 3 to the “connect” position. The line finder should hunt to No. 1 bank contact, and, after a short pause, should step over the faulty circuit and stop finally on No. 2 bank contact.

Repeat the test on all line finders in sequence.

62. Test 8. Forced step-on feature of the Assignment Switch when a Connecting Link Fuse is blown.—Simulate a blown fuse on No. 1 connecting link by connecting the alarm bar to battery. Throw key 4 to the “1,200-ohm loop” position, and, on restoring the key, note that the selector, picked up, receives one impulse. Continue these operations and note that No. 1 connecting link is passed.

Repeat the test on all connecting links in sequence.

63. Test 9. Step-on of Assignment Switch when a Selector has failed to restore to normal. Wedge No. 1 selector in the off-normal position. Throw key 4 to

the "1,200-ohm loop" position, and, in a manner similar to that employed in Test 8, prove that No. 1 connecting link is passed.

Repeat the test on all connecting links in sequence.

NOTE. *During the foregoing tests, Nos. 1 to 9 inclusive, it should be noted that the assignment switch steps during each call, thus ensuring that the connecting links are taken in sequence.*

In tests where ringing is applied, check that the vibrator contacts are free from sparking.

64. Test 10. Overflow Meter.—Wedge the KF relays of all four connecting links, and throw key 4 to the "1,200-ohm loop" position. The overflow meter should operate once. Dial 0 and observe that the impulses are ineffective. Remove and replace the wedges in each connecting link in turn and check that the links are picked up as the wedges are removed.

Repeat the test on each unit.

65. Test 11. Fault Test Circuit.—Throw key 4 to the "1,200 ohm loop" position and dial 99; throw key 5 and verify that inverted ringing tone is received. The inverted ringing tone should be replaced by number unobtainable tone when any one of the following faults is placed on the equipment:—

- (i) Selector failing to release.
- (ii) Fuse blown.
- (iii) Charging plant failure.

These faults should be simulated and the reception of number unobtainable tone verified; test (i) being made by lifting a selector shaft to the off-normal position; test (ii) by connecting battery to the fuse alarm bar and a fuse alarm stud (two tests); and test (iii) by earthing terminal "F" on the power board. (See Diagram A.T. 2002.)

66. Test 12. Subs. Equipment—Operation under Permanent Loop conditions.—Throw key 4 to the "1,200-ohm loop" position, and note that a selector is seized. Wait until forced release is applied, and then test for Earth on the private of the line block to prove that the P relay of the subscriber's equipment is holding.

Transfer test circuit No. 1 to each circuit on the line block and prove the Earth on the P contact of each subscriber's equipment.

67. Test of Coin Box Lines.—The instruments to be used for coin box lines are "Telephones, No. 123" modified to Diagram A.T. 2028 (see also Para. 77) and additional tests are required as shown in Table I.

TABLE. I.

TESTS TO BE CARRIED OUT ON COIN BOX LINES.

Operation.	Test.	Conditions if the Circuit and Apparatus are clear of Faults.
1. Remove receiver and dial 01. (See NOTE.)	Calling circuit conditions, correct functioning of special impulse control cam on the dial and the operation of the slow-releasing relay.	Exchange operator called. Verify that Coin Box tone has been received by the operator.
2. *Insert two tokens - -	(1) Correct operation of the wire gong signal. (2) Short-circuit on the telephone transmitter.	(1) Operator hears the correct (penny) gong signals. (2) Operator cannot hear the call office.
3. (a) Press button A - -	(a) (1) Deposit of tokens. (2) Removal of short-circuit from telephone transmitter.	(a) (1) Tokens deposited. (2) Call Office telephone restored to normal and conversation with the operator can proceed.
(b) Restore receiver - -	(b) ———	(b) ———

* Sixpenny and shilling gong signals will be tested similarly when necessary by using the equivalent coin.

Operation.	Test.	Conditions if the Circuit and Apparatus are clear of Faults.
4. (a) Remove receiver - -	(a) _____	(a) _____
(b) Insert two tokens - -	(b) _____	(b) _____
(c) Dial 99 - - -	(c) Correct operation of dial.	(c) Ringing tone or N.U. tone heard from Fault Test number.
(d) Press button B - -	(d) (1) Delayed return of the springs operated by B button. (2) Refundment of tokens.	(d) (1) Connection released, ringing tone or N.U. tone cut off. (2) Tokens refunded.
(e) Restore receiver - -	(e) _____	(e) _____
5. (a) Remove receiver - -	(a) _____	(a) _____
(b) Dial 99 - - -	(b) Short-circuit on impulse springs.	(b) No tone received.
(c) Restore receiver - -	(c) _____	(c) _____

NOTE.—Coin Box test (1) should be made through each selector in sequence, and, in addition, the transmission circuit should be checked by speaking to the operator and noting that speech is good. All the tests should be made from each coin box circuit connected to the exchange.

SUBSCRIBERS' APPARATUS.

68. General.—The arrangements to be made at subscribers' premises before the opening of the exchange should be in accordance with T.I. XXXIV, Part 3 except as indicated hereafter.

The arrangements in connexion with subscribers' apparatus should be put in hand in time to ensure that the exchange may be opened at the earliest date.

69. Instruction of Subscribers.—As the automatic system is somewhat novel, mis-operation on the part of subscribers will no doubt occur for a short time after the opening of the exchange. To minimize trouble from this source, opportunity should be taken, when the new instruments are being fitted, to explain the meanings of the three tones, viz., Number Unobtainable Tone, Busy Tone, and Ringing Tone. It is not practicable, however, to have the tones available for demonstration purposes before the opening of the exchange.

70. Departures from T.I. XXXIV, Part 3, which details the procedure to be followed in connexion with larger types of automatic exchanges, are detailed in the following paragraphs.

71. Party Lines.—All references to party line working in the Instructions should be ignored.

72. Conversions.—For subscribers' lines to be converted from manual to automatic working, the Instructions prescribe the arrangements to be made for most of the existing types of manual telephones and circuits. For coin box lines, however, the "Telephone, No. 123" should be modified as described in Para. 77 and the method of transfer described in Para. 79 should be adopted.

73. Private Branch Exchanges.—If there are no subscribers' lines with P.B.X. switchboards to be converted to automatic working, all reference in the Instructions to P.B.X. working should be ignored. If, however, there are any lines equipped with P.B.X. switchboards, full particulars of the installation should be submitted to Headquarters.

74. Dial Label Alteration.—The automatic telephones to be used (*i.e.*, "Telephones Nos. 121 and 150") should be provided with "Dial, Auto, No. 10

FA" and the "Label, No. 138B" must be marked up locally in accordance with Circular, Telephones, 438 in the Monthly List for January, 1928. In addition, the figure 1 must be inserted after the 0 in the upper phrase on the label so that it reads "in case of difficulty dial 01."

75. Dial Speed.—In order that the dial speed tests referred to in T.I. XXXIV, Part 3, Para. 31 (h) may be effected, a "Tester, No. 43" should be requisitioned if one is not available locally. The tester should be returned to the Stores Department, after the change-over, unless it is needed to meet the requirements of T.I. XXXIV, Part 3, for some other automatic exchange transfer in the district. It is not intended that a dial-speed tester shall be fitted permanently at a rural automatic exchange. (See also Para. 111.)

76. Subscriber's Instruction Card.—The instruction card for use at the premises of subscribers connected to rural automatic exchanges is T.E. No. 384, which should be requisitioned in the usual way.

LINES EQUIPPED WITH COIN BOXES.

77. Modifications required.—The arrangement of coin box lines and subscribers' lines provided with coin boxes, described in T.I. XXXIV, Part 3, should be modified for rural automatic exchanges to enable a caller to obtain and speak to the Operator by dialling a two-digit number commencing with the digit 0 (e.g. 01) instead of dialling 0 simply, as is the existing scheme for automatic exchanges, other than exchanges of the rural automatic type.

Diagram A.T. 2028 shows the circuit arrangement in schematic form, and it will be seen that "Telephone, No. 123" should be slightly modified. Diagram A.T. 2029 shows the wiring arrangement and indicates the method of connecting the additional relay and condenser, which are contained in a separate box. The disposition of the apparatus should be the same as that shown on the latest issue of Drawing E.C. 1349, except that the relay box should be put in the top right-hand corner of the wallboard in the space occupied by "Frame, Notice, No. 8." The latter should be fitted in the position shown dotted on the left side of the wallboard.

The above arrangement must be effected for all stations equipped with coin boxes, whether in cabinets or in buildings. If a suitable wallboard is not listed in the Rate Book, it should be made locally. The box containing the relay and condenser may be obtained under the title of "Relay, No. 281 AN."

The testing of coin box circuits is dealt with in Para. 67.

78. Training facilities for Traffic Staff.—In order that the Traffic Staff, at the manual exchanges to which the rural automatic exchange is connected, may become acquainted with the essential feature of the multi-coin box, a "Telephone, No. 123" should be obtained on loan and handed to the District Manager, but no circuit should be provided. The instrument should be requisitioned immediately possession of the site is taken and where a number of rural automatic exchanges are in progress in the same District, the instrument may be transferred from place to place provided that ample time for training is assured in each case.

The instrument which is to be fitted in the kiosk should not be used for the above purposes.

79. Transfer Arrangements.—In a transfer from an existing exchange, the procedure laid down in T.I. XXXIV, Part 3, requires the provision of auxiliary equipment and the working of the new prepayment coin box on a postpayment basis until the time of the transfer. For rural automatic exchanges, however, it is desired to avoid this special arrangement, and the procedure should be to assemble all the apparatus for the coin box station on a wallboard in preparation for the transfer to automatic working and, at the time of the transfer, to replace the existing apparatus entirely and to connect the new apparatus to the exchange.

OPENING OF THE EXCHANGE.

80. Attendance after opening.—In view of possible mis-operation by subscribers and to ensure that the equipment is functioning satisfactorily, it will be necessary

to provide more or less constant day attendance during the first few days after the new exchange has been opened. It will be convenient, therefore, if the new equipment is brought into use in the early part of the week, say, on a Monday or Tuesday, thus allowing the exchange to be working smoothly by the weekend, when, no doubt, the daily attendance can be withdrawn.

81. The Officer in attendance at the exchange during the first few days should give special attention to :—

(a) Keeping a close watch on the battery discharge to arrive at a decision in regard to the frequency for recharging.

(b) Watching for selectors held for unnecessarily long periods by reason of subscribers holding a connexion on number unobtainable tone or busy tone. The officer should trace the subscriber's number and then take steps to explain matters. In repeated cases the subscriber should be visited and the correct use of the telephone demonstrated.

To facilitate the work under (b), it is desirable that a "Telephone, No. 80" fitted with a "Plug 410" should be obtained upon loan to enable the maintenance officer, by plugging into the test jack on the selector, to enter the connexion, and thus ascertain whether subscribers are held up.

When using a "Telephone, No. 80" for the above purpose, the key must not be depressed unless it is necessary to speak to a subscriber.

After the exchange has settled down to normal working, the "Telephone, No. 80" should be withdrawn.

TERMINATIONS IN PARENT EXCHANGES.

82. C.B. and Auto-Manual Exchanges.—Early requirements at these exchanges have been met by the provision of "Units, Auxiliary Apparatus No. 60," but, in future, the apparatus should be assembled and wired locally; the relays, resistance spools, etc., being accommodated on the apparatus rack and wired to Diagram No. A.T. 2025, Fig. 5.

The Rate Book description of the items to be requisitioned may be ascertained by reference to Diagram A.T. 2026. The type of mounting depends upon local circumstances. When the provision of further junction equipment to Diagram A.T. 2025 becomes necessary, consideration should be given to the desirability of replacing existing "Units, A.A. No. 60" by equipment to be accommodated on the apparatus rack.

83. C.B.S. 1, 2 and Magneto Exchanges.—"Units, Auxiliary Apparatus, No. 60" (Diagram A.T. 2026) should be provided except at exchanges where it is the normal practice to assemble and wire junction signalling apparatus locally and to accommodate it on special apparatus racks.

84. Switchboard Equipment.—Each junction circuit is terminated at the parent exchange on a lamp or indicator, two jacks in parallel and a key, and is not multiplied. The key—No. 282—is used for dialling and for the identification of coin box traffic. It is locking on the dialling side and non-locking on the coin box test side. The labelling for the key is "Dialling" and "Coin Box Test."

The duplicate jacks are provided to enable cords to be changed on established connexions without a clear being given to the rural automatic exchange. The majority of the switchboards, upon which the junctions from rural automatic exchanges terminate, are of the non-multiple type, but at multiple exchanges the junctions should terminate, if possible, on the first "A" position so that through signalling cord circuits may be available for traffic incoming to the rural automatic exchange.

The exact arrangement for the accommodation of the junction equipment is determined by local conditions, but, where practicable, the arrangement shown in Table II should be adopted.

85. Special Junction Equipment Panels should normally be equipped with 5 keys, 10 jacks, 5 lamps (10 lamps in the case of magneto boards) and 5 pegs arranged in vertical strips to accommodate 5 R.A.X. junctions. The keys should be so fitted at the side of the panel remote from the switchboard that cords connected with the jacks on the panel do not interfere with the operation of the keys. Additional panels may be added at the side, above or below according to local conditions. Where the number of positions is likely to reach more than two, the panel should be placed at the non-growing end of a suite, providing that the last position at this end is equipped with suitable cord circuits, otherwise the panel should be fitted at the growing end.

If a second position is fitted where the number of positions is not likely to reach more than two before a change of switchboard is made, the panel, which should not exceed 4 inches in width, should be placed to come between the two positions. Arrangements should be made for the panel to be obtained locally.

86. Calling and Supervisory Arrangements at the Manual Board.—At Auto-manual, C.B., C.B.S. No. 1 and C.B.S. No. 2 exchanges, the lamp associated with the junction equipment is used for calling only. Standard supervisory conditions obtain on these types of boards. At magneto exchanges, two lamps are provided, one of which is used for calling and the other for clearing. On all boards, the calling signal is not extinguished until the key is thrown to the coin box test position.

87. Dialling from the Manual Board.—On all types of boards, the keys are used for dialling as well as for coin box test purposes, one key being associated with each junction. If a dial is already provided for dialling-in to a standard automatic system, the same dial is used for completing calls to rural automatic exchanges, although the dialling arrangements differ.

At two- or three-position exchanges where R.A.X. junctions are accessible to all positions and dialling-in to a standard automatic system is not in force, dials are so fitted as to be accessible to each operator, the arrangements being as follows :—

- (a) Two-position exchanges, one dial fitted centrally,
- (b) Three-position exchanges, two dials, one being fitted on the left of the right position and the other on the right of the left position. The dials should be wired in series; Diagram Misc. 3421 refers.

In the case of exchanges fitted with dials for dialling-in to standard automatic systems, only one dial—that on the position accommodating the R.A.X. junctions—is available for dialling R.A.X. subscribers.

88. Transfer circuits.—Diagrams A.T. 814, C.B.S. 638 and C.B.S. 589 refer. For multiple exchanges, and also non-multiple exchanges where R.A.X. junctions are not directly accessible to all operators, jack-ended transfer circuits should be provided from the outgoing junction multiple to the position on which the R.A.X. junctions are terminated.

Visual Engaged Signals should not be provided in the case of C.B, C.B.S. 1, C.B.S. 2 and Magneto Exchanges.

GENERAL NOTES.

89. Key Mountings.—A special mounting—"Key Mounting KY"—should be requisitioned for C.B.10, 10A, C.B.S. No. 1 Multiple and C.B.S. No. 2 exchanges. The mounting accommodates 10 keys.



















































Owing to the varying conditions, it is not proposed to make stock provision for Key Mountings to cover C.B.S. No. 1 Non-Multiple and Magneto exchanges. The requirements should be met by screwing the key plates to the spacing strips, or alternatively, to the special junction equipment panel. (See Para. 85.)

Where the parent exchange is of the C.B. No. 1 type, local arrangements should be made for the fitting of the keys; the provision of a special key mounting is not justified.

90. Pegs.—Special numbering pegs are required for insertion in the lamp jack required for Auto Manual, C.B. No. 10, 10A, 12, C.B.S. No. 1 Multiple and some Magneto Exchanges. (See Para. 85.) "Pegs, No. 48" are suitable for this purpose.

TABLE II

Accommodation of Junction Equipment on various types of Switchboard.

Type of Switchboard of parent exchange.	Location of R.A.X. Junctions.	Arrangement.
C.B.1	Answering Field. (See Para. 89).	  Jack & Label.  Jack.  Lamp.  Dialling  Lever Key.  Coin Box Test.
C.B.10, C.B.12, C.B.S. multiple and Auto-manual.	In the subscribers' answering field. Some of the normal equipment in one panel should be removed if necessary. (See Paras. 89 & 90).	  Jacks.   Lamp & Peg.  Dialling  Lever Key.  Coin Box Test.
C.B.9.	Calling signal and lever keys at the bottom of the space normally occupied by subscribers' and junction indicators, the normal indicators being removed. These should be limited to the bottom three rows of ten. Jacks in the junction multiple field.	 Label.  Indicator.  Dialling  Lever Key.  Coin Box Test.   Jacks & Label.
C.B.S. N°2. $\frac{30 + 60}{240}$ $\frac{30 + 60}{160}$	At the bottom of the left-hand panel of the centre position in the space normally available for the extension of junction indicators and jacks. (See Para. 89).	 Label.   Jacks.  Indicator.  Dialling  Lever Key.  Coin Box Test.
C.B.S.1 $\frac{5 + 60}{135}$ $\frac{20 + 60}{140}$	On the centre position above the junction equipment if possible. Otherwise in a special panel on the side of the switchboard. (See Paras. 85, 89 & 90).	 Indicator or Lamp.  Label   Jacks.  Dialling  Lever Key.  Coin Box Test.
Magneto 3 position multiple sections	In the subscribers answering field. Otherwise in a special panel on the side of the switchboard. (See Paras. 85, 89 & 90).	 Designation Strip.   Jacks   Lamps.  Dialling  Lever Key.  Coin Box Test.
Magneto 50 & 100 line sections.	Special panel on the side of the switchboard (See Paras. 85, 89 & 90).	 Dialling  Lever Key.  Coin Box Test.  Jack.  Lamps.  Jack  Peg

91. Relays 56A.—At Auto-Manual and C.B. Exchanges where apparatus is assembled locally (*see* Para. 82), “Relay 56A” should be mounted vertically to ensure reliable operation.

Local arrangements should be made for mounting relays. These should be placed on the apparatus rack, in such a position as to allow of the removal of the covers.

SECTION III. MAINTENANCE.

92. General.—The section deals with the maintenance of Rural Automatic Exchanges, the equipment at which is designed and installed to reduce exchange visits to a minimum.

93. Fault Test Number and attendances to faults.—No alarms are provided in connexion with the automatic equipment at R.A.Xs. A fault test number, 99, is furnished, and, when this number is dialled over a junction, signal tones are used to indicate conditions at the R.A.X. in the following manner :—

(a) *Inverted Ringing Signal.*—When received, indicates that the faults in (b) and (c) do not exist.

(b) *Number Unobtainable Tone.*—When received, indicates that one of the following conditions obtains :—

(i) A selector has failed to restore.

(ii) A fuse has blown.

(iii) The engine has stopped before charging has been completed.

(c) *No Signal or Tone received.*—Indicates that :—

(i) Ringing has failed or

(ii) The junction is out of order. (If more than one junction is available a confirmatory test should be carried out on another junction.)

Arrangements should be made with the Traffic Staff for the test number to be dialled by the operator at the parent exchange at 8 a.m., 12 noon, 4 p.m. and 8 p.m., or at other times to suit local conditions. When a fault is indicated, it should be reported in the usual manner. If a fault is brought to notice after normal hours of duty, the Traffic Staff should be advised as to the procedure to be followed. This will vary in accordance with local conditions and will depend on the location of the R.A.X. and the means of transport, the place of residence of the R.A.X. maintenance officer and the method of communicating with him and whether the parent exchange has continuous attendance or not.

If it can be achieved without undue inconvenience or expense, attendance should be given to all faults. Otherwise attendance should be limited to the faulty conditions described in Para. 93 (c), as in these cases the whole exchange is affected.

If necessary, Circular A.T. 105 should be consulted as a guide in connexion with emergency duty rotas.

Faults on subscribers' instruments, reported after normal hours of duty, should be dealt with in accordance with Engineering Regulations, Division E, Section E², Para. 23.

94. Keys of R.A.Xs.—Two keys are normally provided with each R.A.X. One should be retained by the maintenance officer who normally attends the exchange, and the other should be kept in the key cabinet in the manual switchroom of the parent exchange. If a second maintenance officer is liable to be called out in case of emergency, he also should be provided with a key. The keys should carry a label bearing the name and address of the R.A.X.

95. Reading of Subscribers' Meters.—The Commercial Staff are responsible for the reading of subscribers' meters but, where it would not be economical for them to undertake the work, arrangements may be made with the District Manager for the maintenance officer, during one of his periodical visits, to call the readings over the telephone to the District Manager's office. In this connexion, however, no undertaking can be given to telephone the readings at a specific time or date.

96. Fire Extinguisher.—The Engineering Department is responsible for the maintenance of the Petrolux Extincteur, which should be inspected in accordance with Engineering Regulations, Division A, Section A³, Para. 176.

97. Periodicity of cleaning and precautions against dust.—Arrangements should be made for the periodical cleaning of the exchange. The plan adopted and the frequency of the operation must depend upon local circumstances, but it is necessary to attain as high a standard of cleanliness as is reasonably possible.

In all cleaning operations, care should be taken to ensure that dust is entirely removed instead of being dispersed into the atmosphere to settle elsewhere. *The units must, of course, have the front and rear doors in position and clamped while cleaning is being carried out.* Reference should be made to T.S.I. Serial 17 dated 10/10/28 in regard to the actual cleaning methods to be followed.

Floor dressing materials should not be kept at the rural exchange.

The Engineering Department is responsible for ensuring that cleaning operations are so performed as to avoid risk of damage to plant from dust or damp.

98. Service Telephone.—A spare multiple number should be jumpered to a spare line block number, and the circuit connected *via* the main frame to the "Telephone, No. 121," as indicated in Diagram A.T. 67. The multiple number should be communicated to the test clerk at the control centre and to the supervisor-in-charge at the parent exchange, so that, if necessary, the maintenance officer may be called when on duty at the R.A.X. The multiple number should not be changed unless the circuit is required for other purposes, and any change should be communicated to the officers above-mentioned.

99. Record of Subscribers and Junctions.—A local record of subscribers' and junction circuits should be made on a card, as indicated in Appendix No. VI. A plan of the distributing pole should also appear on a card. The particulars should be inserted in pencil so that alterations may easily be made. The cards should be kept in the card index box.

100. Conversation with subscribers.—Conversations over the telephone with subscribers or their employees should be conducted in a businesslike manner, with a view to creating confidence in the service and assuring subscribers that their interests are being consistently observed. The officer should say "Telephone exchange speaking" before he proceeds with the matter in hand. When a subscriber has been rung in error, the officer should remain in circuit and explain that the line is being tested.

101. Precautions against false metering.—In dealing with faults, care must be exercised to avoid manipulating relays, switches or selectors in such a manner that a subscriber's bell is rung or the meter operated inadvertently. If the subscriber's meter is operated, the test clerk at the control centre should be advised so that an entry may be made on form T.E. 497 which is kept at the test desk. Similarly, when, for service purposes, an Engineering officer makes a call over a subscriber's line, he must advise the Test Clerk to include the call in the return on form T.E. 497.

102. Ventilation.—The R.A.X. building is provided with hollow walls and the automatic unit is constructed with a double-steel casing to avoid rapid changes of temperature and the consequent deposition of moisture.

The front and rear doors of the units should be secured in position with all the clamps unless work is actually being carried out in the unit.

The window and door of the building should be kept closed whenever the weather conditions are such that dampness is present in the atmosphere.

LABELLING AND MARKING.

103. Connecting links should be numbered consecutively, the first link in the first unit being No. 1, the first link in the second being No. 5, and so on. The numbers should be engraved on "Labels, No. 88, white" and fitted in the holders supplied on the selectors and line finders.

104. Subscribers and junctions.—The chart showing the allocation of subscribers' equipments in each unit should be kept up to date. The particulars should be written with pencil to facilitate alteration.

105. Subscribers' Meters.—The three classes of meters, viz. those on (a) measured service lines, (b) spare number circuits, and (c) service lines, should be dealt with as follows:—

(a) No special marking.

(b) "Blanks, Meter" should be used.

(c) A thin white vertical line should be painted on the inside of the meter glass in the centre of the meter face.

MAINTENANCE TOOLS AND SPARE PARTS.

106. Provision of Tools and Spare Parts.—The tools required for exchange maintenance are detailed in Appendix No. IV and tools for the maintenance of subscribers' apparatus are shown in Appendix No. V. A number of them should already be held by the maintenance officer, but the remainder should be requisitioned in ample time for the opening of the exchange.

A copy of the manufacturers "Spare Parts Folder" is included with each unit, and should be kept at the rural automatic exchange. For the present, when a part is required for replacement purposes, it should be identified by means of the diagrams of the folder, and obtained direct from "The General Electric Co., Ltd., Telephone Works, Stoke, Coventry," the code number and description given on the diagram together with the number of the latter, being quoted (*see also Para. 121 (b)*).

The tools required for exchange maintenance and the spare parts should be wrapped in dry chamois leather, "Selvyt" cloth or other suitable material to avoid rusting, etc. The items should be stored in one of the drawers of the cabinet.

107. Spare dials for Manual Board at the Distant Exchange.—If the parent exchange is automatic or a manual dialling-in exchange, the provision of spare dials should already have had attention. If not, spare dials should be held by the supervisor on the basis of one dial per five switchboard positions with a minimum quantity of two. The dials must be fitted with the plug portion of the mounting in use to facilitate rapid replacement of faulty dials. In order that a record of the use made of spare dials may be kept, they should be numbered consecutively by a small number painted in white on the underside.

Similar provision should be made at all other exchanges having direct junctions to the R.A.X.

108. Spare dials for men on Subscribers' Maintenance.—Each man engaged on the maintenance of the R.A.X. subscribers' apparatus should carry two spare dials. As these officers cannot obtain assistance as regards dial tests, any dial thought to be faulty should be changed.

109. Spare dials and spare parts.—In addition to the spare dials carried by maintenance men visiting subscribers' premises, at least two spare dials of each type should be held at their Headquarters. This basis of provision should be reviewed from time to time and reduced if subsequent experience renders a change advisable.

110. Dial repairs must not be carried out at the rural exchange. If there is a main automatic exchange with a repair centre at a convenient distance, the dials may be sent there for repair, the instructions laid down in Part 24A, being followed. Where there is no convenient repair centre, faulty dials should be sent to the Stores Department under Maintenance exchange procedure.

111. Dial speed Tester.—The procedure laid down in Part 24A, Para. 13, is impracticable for an R.A.X. and dial-speed testing should be carried out once every three months in the following manner.

A "Tester, No. 43" should be obtained on loan from the district repair centre or the Stores Department, and fixed in position on the line test case (Diagram A.T. 67). Each subscriber should be called in turn and requested to dial 0, and dials which are outside the limits of 9 to 11 impulses per second should receive attention. If the dials on the positions serving R.A.X. junctions at the distant exchanges are not checked by other means, they should be included in the test. *The Tester should be returned immediately the tests are completed.*

112. Labelling of Dials.—Care must be exercised to ensure legibility in labelling the dials of automatic telephones. The subscriber's number shown upon the dial label should be printed neatly with black indian ink in plain figures similar in character to those indicated in "Service Instructions, Division E8—Fig. (1)." Specimen markings are shown on Diagram A.T. 733.

EXCHANGE MAINTENANCE.

113. Maintenance visits should be made during the hours of daylight, thus facilitating all operations and avoiding the use of artificial light.

It is anticipated that the 40 ampere-hour cells installed initially at a 25-line exchange will require recharging at fortnightly intervals, but the period must be ascertained locally as indicated in Section II, Para. 81. *If the period between charges is less than one week, a report on the matter should be submitted to Headquarters.*

Assuming that the batteries do not require attention more than once a week and that there are no faults at the exchange, a weekly visit should be made for the purpose of routine testing and charging if necessary. The visit should be made on a Friday in order that any faults may be cleared and the battery charged before the weekend. If, however, faults demand attention at or near the exchange earlier in the week, the weekly routine test duties may be carried out during one of these visits provided that the officer is quite certain that the battery will suffice until the following Friday week.

The tests detailed in Paras. 114–116 should be made immediately on each visit to the exchange, irrespective of the purpose of the visit.

114. Voltage Test.—Both batteries should be tested for voltage and the specific gravity of the pilot cells should also be taken. If the voltage of the battery on discharge is below 46, or should the specific gravity reading indicate that the remaining capacity is not ample to suffice until the next normal visit, the spare battery should be put on discharge, and recharging of the discharged battery should be commenced immediately.

115. Subscriber's line Test.—Since no indication is given of permanent loop or Earth faults on subscribers' lines, the following test should be carried out to find any circuits which are faulty and held on the P relays.

Connect the positive 50-volt terminal of a "Detector, No. 2" to Earth and tap a wire from the negative terminal of the detector on the negative lines of all the working circuits. A deflection of about 46, dependent on the exchange voltage, should be obtained on lines which are O.K. and not in use at the time of the test. A note should be taken of those lines on which a lower deflection is obtained, and the calling equipments associated with those lines should be examined. On engaged circuits both the K and the P relays will be operated, but on faulty circuits the P relays only will be energized. Any circuits in the latter condition should be tested by means of the line test case; the faults should be reported to the supervisor at the parent exchange and dealt with immediately.

116. Tone relay Test.—The receiver of the telephone connected to the line test case should be removed, and the service number dialled to prove the operation of the tone relay. Busy tone of correct intensity should be received.

117. Before leaving the exchange, the maintenance officer should satisfy himself on the following points —

- (a) That no markers are left, unnecessarily, in selector jacks.
- (b) That the headgear lamp and all other testing equipment is disconnected.
- (c) That all switch and relay covers are in position.
- (d) That the front and rear doors of the units are clamped in position, all the clamps being used.
- (e) That the battery on discharge is in such a condition that there is ample capacity to last at least until the next visit.
- (f) That the window is shut and fastened.
- (g) That the lighting is switched off.
- (h) That a call is made from the line test telephone to No. 99 and the receipt of ringing tone verified.
- (j) That a call is also made from the call office to the parent exchange and the operator asked to verify that coin box tone is received. This call can conveniently be used to report to the control centre that the maintenance officer is leaving the exchange.
- (k) That the door of the exchange building is locked and the entrance gate closed.

118. Filing of diagrams.—One of the drawers of the cabinet should be used for filing Contractor's and Departmental diagrams and any other necessary records. One copy of each diagram referring to the exchange equipment should be held

and must not be removed from the exchange. Each diagram should be enclosed in a cover (S.S. 417, File, Manila, Regi-Back) which should bear the diagram number on the top right-hand corner.

119. Uses of Test Jacks.—Each selector is provided with three test jacks which are arranged in three spring sets of two springs each.

When the top pair of springs on a selector is short-circuited, Earth is extended to the bank contact of the assignment switch associated with the connecting link, thus busying the link. The jack should be short-circuited by means of "Marker, No. 1" when adjustments are being made to the selector or line finder. Care should be taken to see that markers are not kept in the jacks longer than is necessary. A connecting link should not be left busy unless it requires the replacement of a part not in stock, when immediate steps must be taken to secure the required part.

The middle pair of springs are connected across the calling side of the transmission bridge of the selector. The A relay may thus be operated by short-circuiting the two springs.

The bottom pair of springs, when short-circuited, start the time delay switch and relay timing group, thus enabling the switch to be tested without the necessity of making a call.

120. Battery charging and maintenance.—The secondary cells should be charged and maintained in accordance with the instructions contained in the log book (T.E. 1122) and the instructions in the following paragraphs should also be observed. The charging set should be maintained in accordance with the makers' instructions.

Petrol for an engine charging set should not be stored on the exchange premises. It is estimated that about nine pints of petrol are required for a full charge of the battery. A little more than this quantity should be bought, mixed with the required amount of oil, and the whole placed in the petrol tank at the beginning of a charge. Experience soon shows the proper amount required. It is important that the quantity of petrol placed in the tank should be only slightly more than that for a full charge, so that the risk of a serious overcharge in the event of failure of the cut-off device is thereby eliminated. Any excess of petrol should be used in the maintenance officer's official motor cycle, or stored in a convenient screw-stoppered tin placed in the galvanised box containing the petrol tank.

Care should be taken to see that the water tank is full. The water level must not be allowed to fall below the point of entry of the top pipe into the tank. Water for replenishing the tank should be obtained by the best means available locally and the proportion of anti-freezing compound should be maintained.

It is essential that a battery taken off discharge should at once be put on charge.

A quantity of distilled water may be kept in the exchange in a "Bottle, No. 21." Sulphuric acid must not be stocked.

The spring contacts of the no-load release relay must be adjusted so that they just permit the entry of the gauge without causing any movement of the springs; correct alignment with the blade is essential.

121. Apparatus Adjustments.—Adjustments to the automatic plant must be carried out strictly in accordance with standard adjustment instructions. It is necessary to avoid haphazard or guess and trial adjustments.

Part 24D deals with the adjustment of rotary line switches and two-motion selectors. One copy of the Instructions should be kept at the Rural Automatic Exchange. They supersede the Contractor's Adjustment Bulletin, which should continue to be used for the relay adjustments.

The following notes should also be observed :—

(a) The Contractor's schedules quote milliamperes current values for relays in addition to mechanical adjustments. It is not proposed at this stage to provide a means for checking current values. If the mechanical adjustments are carried out, a relay should be in correct adjustment without resort to a current test.

(b) Replacement of parts should not be made unless they are unmistakably called for by breakages, loss, serious wear or other damage.

(c) The Maintenance Officer should accustom himself to the sound of switches under normal operation so that faulty switches may be readily detected.

(d) All adjustments to or renewals of parts of switches should, where practicable, be carried out with the switch in position. If the removal of a selector is unavoidable, it should be verified that Earth is extended to the assignment switch bank contact associated with the selector, *via* the selector jack.

(e) When a fault is caused by the failure of a relay contact, including that made by a dirty contact, a check should be made to verify that there is a proper amount of follow to the springs so as to provide a rubbing contact. If the follow is absent, the relay should be readjusted to the specified adjustments.

Paper or similar material must not be employed for the temporary insulation of relay and other contacts. "Tool, Instrument, No. 161" should be used.

122. Cleaning of Selector bank contacts.—It is important that bank contacts should be maintained in a clean condition and "Tool, Instrument, No. 120" should be used for this purpose. The curved steel blade of the tool should be slid into a length of the outer covering of a switchboard cord, so that the covering completely envelopes the blade and allows part of the covering to overhang at the non-handled end. The tool is held by the handle. The free end of the cord covering is placed horizontally in the bank to be cleaned, and is given a circular motion so that the contacts are rubbed by the cord covering.

The frequency with which bank contacts require cleaning depends upon local conditions, but once in three months should be adequate.

123. Heating of Soldering Iron.—For the purpose of heating soldering irons for maintenance work one "Oven, Soldering, Small" and a supply of "Fuel, Meta" should be obtained.

124. Soldering on Bank Multiple.—For faults on bank multiple wiring where the use of a soldering iron is required, a "Bit, Soldering, Instrument, with small tip" should be used. When using the iron, care should be taken to see that the bank wiring and insulation are not damaged, and are protected by the use of a small piece of sheet tin.

125. Scrap wire should be taken to the maintenance officer's headquarters, since no receptacle is provided at the rural exchange.

126. Headgear lamp.—A "Lamp, Headgear, No. 2" is provided to facilitate the adjustment of relays etc., particularly where the use of both hands is required. The lamp has a cord and plug which may be connected to the battery jack of any unit.

The lamp should be used only when absolutely necessary, as its continued use results in a serious drain on the main battery.

127. Subscribers Originating Calls barred.—When the Traffic Department requests that a subscriber shall be prevented from originating calls while still being allowed to receive calls, the following procedure should be carried out on the subscriber's calling equipment:—

Insulate the contact of the P relay (P2 in Fig. 3), which is in series with the L relay winding, by means of a small piece of vulcanised fibre or bakelite. The fibre should be about as thick as that used for meter blanks and should be so bent to a channel shape that it slides over the lowest spring and separates it from the moving spring but does not lift the latter high enough to make contact with the top spring. Care should be taken to see that the fibre does not lift the moving spring so that the brass stud on it makes contact with the lower spring, thus defeating the object in view. The fibre should also be so placed that repeated operation of the P relay does not dislodge it.

The contacts of the L relay should not be insulated to effect an "O.C.B." condition.

128. Subscribers "Temporarily out of Service."—When the Traffic Department requests that a subscriber's service shall be suspended altogether, *i.e.* both originating and incoming calls must be stopped, the circuit should be disconnected on the protector side of the main frame by inserting two "Wedges, Wood, for Protectors, H.C. & T." in the protector springs associated with the positive and negative lines.

In order that subscribers calling the T.O.S. line may be informed that it is unobtainable, the positive multiple block tag of the T.O.S. line in the first unit should be strapped by a short piece of wire to the N.U. tone tag.

Where subscriber's lines are "T.O.S." or "O.C.B." an entry should be made on the fault card at the control centre to show the time the circuits were disconnected. When service is restored, the time of restoration should be shown.

FAULT PROCEDURE.

129. The fault procedure in connexion with the rural automatic exchange equipment should conform generally with Circular E.18 except as modified by Para. 130.

130. Testing and Control of Faults.—Junction faults should be tested from the manual board upon which the junction terminates. Faults on subscribers' circuits should be tested from the R.A.X. All faults should be reported to the control centre and the test clerk at this exchange must arrange for the necessary tests to be effected. He is also responsible for all fault records.

131. Fault cards should be kept at the control centre on the following basis :—

(a) 1 card T.E. 700, 702, 704 or 705 as required for each R.A.X. subscriber and junction.

(b) 1 card T.E. 580 for each connecting link, numbered as indicated in Para. 103.

(c) 1 card T.E. 580 for each assignment switch with associated relays and overflow meter.

(d) 1 card T.E. 580 for each set of common apparatus (designated "Common apparatus, Unit 1" etc.)

(e) 1 card T.E. 580 (suitably modified) for the power plant.

132. Subscriber's Mis-operation.—When it is observed from the fault card that a subscriber's circuit is repeatedly causing trouble by reason of the mis-operation of the telephone, steps should be taken to visit the subscriber and instruct him in the correct use of the instrument.

133. Recurring Faults.—To determine what faults occur most frequently, and to keep a check on the effective clearance of them, entry should be made, in the recurring fault book, of faults which recur as indicated in the following table :—

TABLE III.

<i>Apparatus.</i>	<i>Supervising Officer to investigate if two faults occur within :</i>
Subscribers' calling equipment and meters	- 4 months.
Connecting Link - - - - -	- 2 "
Assignment Switch - - - - -	- 2 "
Common Apparatus - - - - -	- 1 month.

134. Faults F.O.K.—A fault card, T.E. 580, should be provided at the control centre for recording all faults in connexion with the R.A.X. which have been given out to the maintenance officer and found O.K.

The card should be scrutinized at frequent intervals by an engineering supervising officer to ascertain the type of fault which is habitually F.O.K. These cases should not be carried to the recurring fault book unless they occur repeatedly in the same piece of apparatus.

135. Entries on fault cards and fault records should be concise with due regard for clearness. A list of authorized abbreviations for R.A.Xs. which should be used for entries on fault dockets and fault cards is given in Appendix No. VII.

136. When a fault of a novel or instructive character occurs on automatic apparatus, the faultsman should prepare a brief report for submission to the Engineer-in-Chief. Form T.E. 646 is provided for this purpose. If a fault, so reported, is considered by the Engineer-in-Chief to be of sufficient general interest, details will be circulated to all R.A.Xs. The arrangement is not intended to interfere in any way with Awards Committee procedure.

137. Any cases of burnt-out coils of relays, etc., should be made the subject of a special report to the Engineer-in-Chief, full details of the circumstances being given.

138. Busying faulty circuits.—In cases of faults on the positive side of junction circuits when the negative line is O.K., a busy condition may be established by earthing the negative line. Relay L operates at the R.A.X. and subsequently busies the circuit by means of relay P. When engineering staff is available, the busying should be carried out from the end remote from the R.A.X. and an officer should then be sent to give attention to the fault. Dependent upon the location of his headquarters, and also upon the nature of the fault, it may be cleared “en route.” If it is not, the officer should proceed to the R.A.X. and, if there is more than one junction in the group, the faulty one should be busied by disconnecting the private jumper on the multiple block and earthing the tag.

When it is anticipated that a faulty subscriber’s circuit will be unworkable for some time, say for more than half an hour, the jumper on the positive multiple block tag should be disconnected and the tag connected temporarily to N.U. tone.

For the temporary connections and also for general testing, it will be found convenient to provide several lengths, say 6, of “Cord, Instrument, 101” each about 3 ft. long and terminated with “Clips, Test, No. 15.”

A circuit must be restored to normal immediately the fault is cleared.

139. Check of R.A.X. voltage from Parent Exchange.—Where the testing is carried out at a parent exchange on a standard voltmeter reading to 60 volts or above, a rough test of the voltage of a rural automatic exchange battery may be made thus :—

Intercept an R.A.X. junction on the main frame and test for battery on the negative line, using the test desk voltmeter with the high resistance winding and no shunt. Owing to the high resistance of the voltmeter, the L relay associated with the junction at the R.A.X. end cannot operate, and the voltage of the R.A.X. battery may be calculated from the formula :—

$$V = \frac{(R + r + 400)D}{R}$$

Where V = Voltage of the R.A.X. battery,

R = Resistance of the voltmeter in ohms,

$r + 400$ = Resistance of negative line of junction plus the coil of relay L.

D = Deflection on the voltmeter.

It should be noted that the formula makes no allowance for a low insulation or other fault on the junction.

It is left to the discretion of the Superintending Engineer whether a test of this nature is carried out. For guidance, the decision should depend on whether the junction consists of open wire or cable and, in the former case, what insulation resistance obtains. The test to be of value should be one of the first duties of every working day.

140. Test of Time Delay Switch from parent exchange.—A test of the correct functioning of the time delay switch may be made from the parent exchange main frame; a receiver or a Detector No. 2 may be employed as follows :—

(a) Make the test at a quiet time to avoid any interference with normal traffic.

(b) Ascertain whether the junction is free, and then disconnect the parent exchange internal portion of the circuit.

(c) When the test is made with a receiver, connect it directly across the junction loop; after a period, of from 15 to 30 seconds, a distinct click should be heard indicating that forced release has been applied to the connecting link.

(d) When the test is made with a Detector, connect it directly across the junction loop and use the 0–500 mA. scale. The deflection varies with the resistance of the junction, etc., and may be between 30 mA and 100 mA, but when the forced release is applied the deflection will drop to about half a division (*i.e.* about 5 mA).

If the delay period is less than 15 seconds or more than 30 seconds, it must be reported as a fault and dealt with immediately.

141. Test of tones from parent exchange.—The N.U. tone may be verified by dialling any spare number on the R.A.X. from the parent exchange manual board.

The busy tone may be tested by dialling the junction number (in single junction R.A.Xs.). Where more than one junction is equipped, the test should be made on the last free junction, and the number of the junction (not 01) should be dialled.

ROUTINE TESTS.

142. Duty Chart.—The routine tests, together with their relative periodicities, are shown in Appendix No. VIII. Each test is given a number and is described in detail in Paras. 146-161.

A routine duty chart should be prepared in such a manner that the tests are spread evenly over the period. The chart should be held at the control centre, and the test clerk will be responsible for advising the maintenance officer regarding the routine duties required to be carried out during the usual weekly visit. Routine testing should, of course, be carried out when, on account of a fault, a visit is necessary, the more particularly if the means of transport are such that the officer has spare time during the visit.

A copy of the routine test duties should be entered on cards and held in the card index cabinet at the R.A.X. The information is merely to assist the maintenance officer in regard to the tests to be performed. All records of work done should, however, be held at the control centre.

143. Record of faults.—When the routine tests for the particular week have been carried out, the maintenance officer should advise the test clerk by telephone before leaving the R.A.X., as follows :—

- (a) Tests completed, no faults found.
- (b) Tests completed, faults found. Full details of the faults and steps taken to remove them should be given.

The test clerk should indicate on the duty chart that the duty has been performed, stating the date and adding a brief note as to the number of faults found. Details of faults and their clearance should be entered on the relevant fault cards in the usual manner.

144. Arrangement of Routine Test Circuits.—The outgoing side of the "Tester, No. 82" (Diagram A.T. 2035) should be connected to a spare subscriber's equipment modified as a coin box circuit, and the line equipment jumpered temporarily to a spare multiple number.

The incoming side of the test case should be similarly connected to another spare equipment and number, but without the coin box modification.

In the following tests the outgoing and incoming sides of the test case are known as test circuits Nos. 1 and 2 respectively.

In exchanges containing more than one unit, when certain tests are being made on the connecting links, it is necessary to transfer test circuits Nos. 1 and 2, together with their associated jumpers to the second, etc., units. To facilitate this, cords terminating in test clips may be used in place of jumpers.

145. Common Apparatus.—During the tests the operation of the common apparatus should be closely observed when brought into use. The following points should be particularly noted :—

- (a) *Assignment Switches.*—Disengaged selectors should be picked up in sequence, and the assignment switch relays should be free from sparking.
- (b) *Relay Timing Group.*—The operation of the relays should be regular and no sparking should occur.
- (c) *Ringling Vibrator.*—The adjustment instructions should be strictly observed for adjustments of the vibrator. The ringling and the ringling tone will be weak in quality unless the adjustment of the vibrator is correct.
- (d) *Tone Relay.*—The quality of the tone should be observed. It should be clear, unvarying, and fairly high in pitch. If the pitch changes or has a rasping quality the adjustments of the relay should be verified and the contacts cleaned with "Tool, Instrument, No. 155."

146. Test 1. Local call. Regular.—Operate key 4 to the "1,200-ohm loop" position, key 3 to the "connect" position, and dial the multiple number of test circuit No. 2. Check that the selector action is smooth, and that there is no excessive sparking. Verify the reception of ringling tone by operating key 5 to the "listen" position. The bell should ring satisfactorily. Trip the ringling

by operating key 2 and check that the meter associated with test circuit No. 1 operates once. Operate key 1 and note that selector relays DA and DB remain operated. Restore key 1, operate key 3 to the "transmission" position and check reception of the tone through the selector by listening in the receiver with key 5 operated to the "listen" position. Restore all keys and note the correct release of the selector.

Repeat this test on all connecting links.

147. Test 2. Local Call. Called line Busy.—Operate key 2, place key 3 in the "connect" position and key 4 to the "1,200-ohm loop" position; dial the multiple number of No. 2 test circuit. Busy tone should be heard when the listening key is operated. Restore all keys to normal and note that the meter associated with No. 1 test circuit does not operate.

Repeat the test on all connecting links.

148. Junction Tests.—Since it is difficult to make tests on the "O" level without interfering with the normal working of the exchange, arrangements should be made for testing the junction circuits as quickly as possible when traffic is at a minimum.

In the following junction tests, tests 3 and 4 refer to R.A.Xs having only one junction in each group, and tests 5 and 6 to R.A.Xs having more than one junction in each group.

Before tests are commenced, the distant operator should be called by means of the telephone associated with the line test case (Diagram A.T. 67), and informed that junction tests are about to be made and that the junctions will be out-of-order for a short time. During the tests the selectors should be watched for 0 level calls. If these occur, the junctions should be restored to normal and the tests temporarily suspended.

149. Test 3. Junction Call. Outlet Free.—Intercept the junction line on the main frame with the plug of the line test case and operate keys 1 and 10 on the test case. From test circuit No. 1, dial the junction under test with key 4 operated to the "1,200-ohm loop" position. The bell of the line test case telephone should ring. Trip the ringing by removing the receiver. Operate key 4 of the line test case and verify reception of coin box tone in the receiver of the instrument.

Restore key 4 of test circuit No. 1, key 4 of the line test case, and replace the receiver.

Repeat the test on all connecting links.

150. Test 4. Junction Call. Outlet busy.—With keys 1 and 10 operated on the line test case, remove the receiver of the line test case telephone. Dial the junction from test circuit No. 1, after operating key 4 to the "1,200-ohm loop" position. Verify reception of busy tone in the receiver of test circuit No. 1 on operating key 5 to the "listen" position.

Repeat the test on all connecting links.

151. Test 5. Junction Call. Last outlet free.—Strap the P and P1 contacts of the first and intermediate lines in a group by means of a piece of bare wire wrapped around the multiple block tags. Earth this wire. Intercept the last junction in the group on the main frame, and operate keys 1 and 10 on the line test case. Dial the first junction of the group from test circuit No. 1, trip the ringing by removing the line test case receiver and test for coin box tone as in Test 3.

Repeat the test on all connecting links.

152. Test 6. Junction Call. All outlets busy.—The conditions are the same as in test 5, except that the receiver of the line test case telephone should be removed before dialling. Dial the first line of the group from test circuit No. 1, and verify reception of busy tone as in test 4.

Repeat the test on all connecting links.

To restore the junctions to normal conditions the bare wire strapping and earthing of the P and P1 tags should be removed immediately tests 5 and 6 are completed and the plug removed from the main frame.

153. Test 7. Forced step-on of Assignment Switch when the connecting link fuse is blown.—Connect battery to the fuse alarm stud of a connecting link. Operate key 4 of test circuit No. 1 to "1,200-ohm loop" position. A connecting link is seized and, on restoring key 4, the selector receives one vertical impulse.

Operate and release key 4 to seize and release the connecting links in sequence. Note that the connecting link on which the blown fuse is simulated is passed.

Repeat the test on all connecting links.

154. Test 8. Step-on of Assignment switch when a selector fails to restore to normal.—Lift a selector shaft to the off-normal position and operate key 4 of No. 1 test circuit in a manner similar to that employed in test No. 7. Note that the selector which is off-normal is passed.

Repeat the test on all connecting links.

155. Test 9. Forced step-on of line finder.—Hold the L relay of a spare subscriber's equipment in the operated position by hand. Note that a line finder is seized, hunts to the bank contact of the calling line, stops momentarily, then hunts round to the same contact again, stops again and so on

Repeat the test on all the line finders.

It should be observed that the wipers of a line finder stop once only during each half-revolution. If more than one halt is made, it is an indication that Earth, which is normally on the P1 bank contacts, is missing and steps should be taken to clear the fault.

156. Test 10. Metering conditions on connecting links.—Connect test circuit No. 2 to a spare multiple number, which must not be on the 0 level, in the first unit. Note the reading of the meter associated with the service telephone. Remove the receiver and dial the number to which test circuit No. 2 is connected. Trip the ringing by operating key 2 in test circuit No. 2 and note that the meter associated with the service telephone registers once.

Repeat the test until all four connecting links in the unit have been tested.

In exchanges with more than one unit the connecting links, which are not available to the service telephone, should be tested by connecting test circuit No. 1 to a spare subscriber's equipment on the unit. The above test should then be carried out by operating key 4 in test circuit No. 1 to the "1,200-ohm loop" position and dialling the multiple number of test circuit No. 2.

157. Test 11. Subscriber's calling equipments and meters.—Connect test circuit 1 to the voltmeter terminals on the line test case. Operate keys 1, 5 and 6 on the line test case.

Make out a schedule headed :—

.....Rural Automatic Exchange.

Routine Test of Meters on (date).

Divide the schedule into three columns headed (i) Subscriber's No. or junction, (ii) Reading before test, (iii) Reading after test.

The calling equipments and meters should be tested in consecutive order and, to avoid interference with engaged circuits and to discover faulty circuits held on the P relays, the test described in Para. 115 must first be carried out on each circuit before the following test is made. Any circuits that are faulty should receive attention and any circuits that are engaged normally should be recorded for test later.

Plug into the first disengaged circuit on the main frame. Make a note on the schedule of the circuit number and its meter reading. Then operate key 4 of test circuit No. 1 to the "1,200-ohm loop" position. Dial the multiple number of the service telephone with the dial of test circuit No. 1. When ringing is received, remove the telephone receiver and observe that the meter associated with the calling line registers once. To avoid waiting for the time delay switch to free the link, step the line finder, by hand, off the bank contact of the calling line. Observe that the connecting link is released and that the K relay of the subscriber's equipment releases, leaving only the P relay operated. Restore key 4 of test circuit No. 1 and make a note on the schedule of the final meter reading.

Continue the test until every calling equipment is proved and restore the test case connections to normal. Any faults should be given immediate attention.

The schedule should be forwarded immediately to the control centre in order that the District Manager may be advised of the advancement of the meter readings.

Since the calling equipment test is required more frequently than the meter test, the former test may be carried out separately by omitting to dial after key 4 of test circuit No. 1 has been operated. The starting of the time delay switch proves that a connecting link has been seized, and the associated line finder should then be stepped on as indicated above to prove the holding of the P relay.

158. Test 12. Time delay Switch.—Set the time delay switch to the third bank contact and lift the receiver of the line test case telephone. Verify that the connecting link, seized, is released after an interval of about 15 seconds. Set the time delay switch to the fourth bank contact and repeat the test, verifying that release occurs after an interval of about 30 seconds.

159. Test 13. N.U. tone.—Operate key 4 of test circuit No. 1 to the "1,200-ohm loop" position and dial any spare number. Verify the reception of N.U. tone by operating key 5 and listening with the receiver.

160. Test 14. Fault test Circuit.—Call 99 from the line test case telephone and note the reception of inverted ringing tone. Then perform the following operations:—

- (a) lift a selector shaft off-normal,
- (b) connect battery to the alarm stud of a connecting link fuse,
- (c) connect battery to a fuse alarm bar,
- (d) tap Earth on terminal "F" of the power board. (See Diagram

A.T. 2018.)

Note that the ringing tone is replaced by N.U. tone in each instance.

161. Test 15. Insulation Test of Subscribers' lines.—The lowest insulation resistance permissible is 50,000 ohms. Subscribers' lines, having an insulation resistance of less than this value, should be treated as faulty but the lines should not be busied unless they are unworkable. The insulation test should be made on subscribers' circuits in consecutive order as described in the following paragraph.

If the circuit is found to be disengaged after having been tested as indicated in Para. 115, the circuit should be entered on the M.D.F., thus connecting the line test case. On the latter, the "Detector, No. 2" should be joined up on the 50-volt scale. Operate keys 4 and 5 of the line test case and note the deflection on the detector. Throw key 3 and again note the deflection. When the exchange voltage is 50 volts, an insulation resistance of 50,000 ohms gives a deflection of 4.5 on the 50-volt scale. Should either deflection be above this figure, the line should be given attention.

SECTION IV. CIRCUIT DESCRIPTION.

162. Introduction.—The automatic apparatus is assembled in units, each having a capacity of 25 lines. Four selectors of the Strowger type, each associated with a line finder, are accommodated in every unit, and provide the means of connection between subscribers' and junction circuits. One selector and its associated line finder forms a connecting circuit, termed a Connecting Link.

Each of the 25 lines in one unit is multiplied over the banks of the four line finders. When more than one unit is installed, all the banks of the selectors in all the units are multiplied together so that any selector has access to any line on the exchange. The trunking diagram illustrated in Diagram T.K. 1329 shows the connections of a rural automatic exchange using two "Units, Auto, No. 5."

When a calling subscriber removes the receiver, the apparatus associated with the line causes a signal to be transmitted over the start wire *via* the assignment switch and bank contact to one of the four line finders in the unit containing the calling line. The line finder hunts for the line and, when it has been found, the calling subscriber is extended to the selector. Then, the assignment switch wipers are stepped round to the bank contacts of the next free connecting link.

The subscriber now dials the two digits required. The first train of impulses—the tens digit—causes the selector wipers to be raised vertically to the corresponding level. The second train—the units digit—rotates the wipers to the bank contacts of the required subscriber's line. When the second digit is dialled, certain relays in the common apparatus are operated and ringing current is generated. Interrupted ringing current is automatically applied to the called subscriber's line and ringing tone is transmitted to the calling subscriber. When the called subscriber removes the receiver, the ringing current is cut off during the silent period and the speaking circuit is established. When the calling subscriber replaces the receiver, the selector is released, but the wipers of the line finder remain on the bank contacts of the calling line until another calling subscriber seizes the connecting link.

Level 0 of the selector is reserved for junctions to other exchanges, the lines to each exchange terminating on groups of consecutive bank contacts. A calling

subscriber requiring connection to an exchange dials 0 and one other digit which is dependent upon the exchange required. The second digit rotates the wipers to the bank contacts of the first line to the required exchange. If that line is engaged, an automatic rotary hunting circuit is brought into use, and the wipers rotate until a free line to the exchange is found. The wipers remain on the free line, ringing current is transmitted to the line and causes a calling signal associated with the junction to be operated in the distant manual exchange; ringing tone is returned to the calling subscriber. In the event of the lines to the required exchange being engaged, the selector wipers are rotated to the bank contacts of the last line in the group, and busy tone is returned to the calling subscriber.

When the junctions are worked on a bothway basis, they terminate in the rural exchange on line equipment and on the line finder bank multiple as ordinary subscribers' lines. Hence an incoming junction call is similar to that of an ordinary subscriber.

Should a subscriber dial a number which is engaged, busy tone is returned. When a spare number is dialled, number unobtainable tone is transmitted to the calling subscriber.

163. The facilities provided by the equipment of a rural automatic exchange employing "Units, Auto, No. 5," are detailed in Paras. 164-170.

164. Subscriber's Calling Equipment is individual to each subscriber, and its functions are as follows:—

- (i) To operate the relays of the assignment switch.
- (ii) To remove busy condition from the line finder banks so that the rotating wipers of the line finder may stop on the calling subscriber's line.
- (iii) To provide for permanent loop condition.

165. Assignment Switch.—One switch per unit. It performs the following functions:—

- (i) Pre-assigns a selector to deal with each subscriber's call.
- (ii) Steps its wipers to the bank contacts of the next free selector, in readiness for the next call, when the calling line is found by the line finder.
- (iii) Operates the overflow meter under certain conditions.

166. Selector with associated line finder (connecting link).—Four per unit are provided; each performs the following operations:—

- (i) The line finder hunts and seizes the calling line or junction and then extends it to the selector.
- (ii) The selector receives the two trains of impulses dialled by the calling subscriber or the distant operator and completes the connection to the required subscriber or junction.
- (iii) Provides a transmission bridge and supplies speaking current to the calling and called subscribers.

167. Ringing and tone equipment.—One per exchange. It provides:—

- (i) Ringing current, by means of a vibrator.
- (ii) Tone, by means of a special buzzing relay.

168. Time Delay Switch.—One per exchange. The switch provides for the application of a forced release condition to connecting links in the case of faulty lines, permanent loop condition, or calling subscriber's mis-operation.

169. Relay Timing Group.—One per exchange. The relays control the operation of:—

- (i) The time delay switch.
- (ii) The ringing equipment.
- (iii) The busy tone.

170. Fault Test Circuit.—One per exchange. The equipment operates only when a distant exchange dials a certain number and informs the operator by N.U. tone or by absence of the ringing signal of the existence of certain faults.

LOCAL CALL.

171. Pre-dialling stage.—A diagram of the connections of the subscriber's calling equipment is shown in Fig. 3, the connections of the connecting link appear in Fig. 4, whilst those of the common apparatus are given in Fig. 5.

In the circuit description given in this and succeeding paragraphs, the contact codes of relay contacts which are in the operated position are printed in clarendon type, thus **L1**.

When a calling subscriber removes the receiver, relay **L** (Fig. 3) operates from Earth, **K3** "y," positive line, subscriber's telephone, negative line, **P2**, 400-ohm coil of relay **L** to earthed battery; **L1** removes the Earth from the **P1** bank contacts of the calling line on the four line finders in the unit containing the calling subscriber, and also closes a circuit for the operation of relays **SA** and **SB** (Fig. 5). These relays operate; **SA1** and **3**, together with **SB1** and **3**, prepare for the subsequent operation of the assignment switch driving magnet; **SA2** and **4** close the circuit of relay **SF** (Fig. 4); **SB2** prepares a circuit for stepping the assignment switch in the case of a blown fuse (see Para. 188); **SB4** prepares a circuit for the overflow meter.

Relay **SF** in the connecting link operates from Earth, **GA1** and **2**, **SA2** and **4**, **AX1** and **2**, assignment switch wiper **2**, 800-ohm coil of relay **SF** to earthed battery; **SF4** "x" connects the driving magnet of the line finder *via* the **dm** springs and **KF6** to the **P1** wiper; **SF1** disconnects a possible circuit for the driving magnet of the line finder; **SF2** closes a circuit for relay **H**; **SF3** prepares a circuit for relay **AX** in the assignment switch; **SF5** connects Earth to one side of relay **KF**. Relay **H** operates; **H1** and **H4** disconnects the positive and negative wipers of the selector; **H2** prepares a locking circuit for relay **H**; **H3** disconnects a possible circuit for relay **F**; **H5** prepares a circuit for the operation of the rotary magnet.

Unless the wipers of the line finder are resting on the bank contacts of the calling subscriber's line, the driving magnet operates to the Earth *via* the **L1** contacts of other subscribers' equipments and relay **KF** is short-circuited in consequence of these Earths. The line finder hunts until its wipers are stepped to the bank contacts of the calling subscriber's line. The portion of the circuit concerned at this stage is shown in Fig. 6.

When the wipers of the line finder come to rest on the bank contacts of the calling subscriber's line, relay **KF** is no longer short-circuited and operates in series with the line finder driving magnet, which does not receive sufficient current over this circuit to cause its operation; **KF1** closes a circuit *via* the **P1** bank for the operation of relay **K** in the subscriber's equipment and to guard the connection from intrusion; **KF2** closes a circuit for the operation of relay **TA** so as to commence the operation of the time delay switch and the relay timing group (see Paras. 182 and 185); **KF3** and **KF4** extend the incoming negative and positive lines to relay **A** in the connecting link; **KF5** prepares a retaining circuit for relay **KF**; **KF6** disconnects the driving magnet of the line finder and prepares a circuit for the operation of the calling subscriber's meter; **KF7** closes a circuit for the operation of relay **AX**. In the subscriber's line equipment (Fig. 3) relay **K** operates from the Earth on the private wire at **KF1** in the connecting link; **K1** prepares a circuit for guarding the line at the final selector multiple; **K2** closes the circuit of relay **P**; **K3** "y" removes the Earth from the positive wire. Relay **P** operates; **P1** extends the private wire from the final selector multiple *via* **K1** to the outgoing private wire; **P2** disconnects relay **L** which releases and, at **L1**, replaces Earth on the line finder **P1** bank contacts of the calling subscriber's line and disconnects relays **SA** and **SB**.

172. Operation of the Assignment Switch and Overflow Meter.—When the circuit of relays **SA** and **SB** (Fig. 5) is broken, relay **SA** releases quickly, but relay **SB** is slow-releasing. This allows an Earth to be extended *via* **SA1** and **3** and **SB1** and **3**, to the driving magnet of the assignment switch. When relay **SB** falls away, this circuit is broken and the wipers are stepped to the bank contacts of the next connecting link as a result of the de-energization of the driving magnet. Should the link be engaged, the assignment switch driving magnet is energized through **AX4** and **5**, **dm** springs, **AS1** wiper and bank contact, **SF3** and **KF7** in the connecting link which is engaged. As a result, the wipers are stepped until a free connecting link is found. By this means a connecting link is pre-assigned to deal with calls as they are originated.

If all four links are engaged, the driving magnet of the assignment switch receives Earth from each of them; consequently, the wipers are driven round until they step to the first bank contacts. Relay **GA** operates while stepping takes place and **GA1** and **2** prevent the operation of the **SF** relays of the links as the wipers pass over the bank contacts.

Should another subscriber in the unit lift the receiver while these conditions persist, relay SB operates; **SB4** closes the circuit to the overflow meter, which operates and locks relays SA and SB *via* its local contact. The assignment switch, however, does not step until the driving magnet receives a full Earth. Immediately a connecting link is released, contact KF1 connects Earth to the overflow meter common and, *via* **SB4**, to the driving magnet with the result that the assignment switch wipers are stepped to the bank contacts of the free link.

If one of the four links becomes disengaged before another subscriber calls, the KF1 contact of the particular link places a full Earth on the overflow meter common before relay SB operates, so that a short-circuit is placed across the meter and the assignment switch wipers are stepped without operating the overflow meter.

Relay A in the connecting link (Fig. 4), having operated over the telephone loop on the closure of **KF3** and **KF4**, closes the circuit of relay B at **A2** and, at **A1**, disconnects the circuit of the release relay R. Relay B operates; **B1** disconnects a possible circuit for the line finder driving magnet (see Para. 188); **B2** provides a holding Earth for relay KF and extends Earth forward to the private wiper of the selector; **B3** and **B4** prepare for the through switching of the negative and positive lines; **B5** closes a holding circuit for relay H *via* **DA5**, **MD6** and **H2**; **B6** prepares a circuit for the operation of the vertical and rotary magnets; **B7** prepares a circuit for relay R (Fig. 5).

The circuit is now prepared for the reception of the impulse trains from the calling subscriber's dial.

173. Dialling Stage.—The calling subscriber now dials the first digit, *i.e.*, the tens digit, and relay A impulses from the breaks and makes at the dial impulsing springs; **A2** closes the circuit of the vertical magnet and relay C. Relay C operates; **C1** provides an alternative circuit for the retention of relay H; **C2** prepares an alternative circuit for the vertical magnet and relay C; **C3** prepares a circuit for relay E; **C4** prepares a circuit for relay J. During the first vertical step, the vertical off-normal springs, N1, N2 and N3, change over; **N1** busies the connecting link to the assignment switch; **N2** prepares the circuit of the release magnet; **N3** renders relay C and the vertical magnet dependent upon the circuit *via* **C2**. Relay B, although disconnected at **A2** during impulsing, retains by virtue of its slow-release feature. Relay R (Fig. 5) operates *via* **A1** and **B7**, but, since the release circuit is broken at **B6**, it is ineffective. Relay C is slow-releasing and it retains while the vertical train is being received. The vertical magnet steps the wipers up to the level corresponding to the digit dialled by the calling subscriber. During the interval between the two impulse trains, relay C releases; **C2** changes the impulsing circuit of contact **A2** over to the rotary magnet and relay E.

The subscriber now dials the second digit, *i.e.*, the units. Relay A impulses again, this time energizing the rotary magnet with relay E in parallel. Relay E retains, while the train is being received, owing to its slow-release features; **E1** is only concerned when the call is to be routed over a junction, reached from level 0; **E2** prevents interference with the circuit by **G5**; **E3** prevents interference by **G4**; **E4** extends relay G to the private wiper in readiness for testing the called subscriber's line; **E5** prevents interference by **G2**; **E6** retains relay H and closes a circuit for the operation of relay MD. Should relay G operate, owing to the private wiper passing over the bank contacts of busy lines on the way round to the called subscriber's line, no interference is caused to the circuit since **E2**, **E3** and **E5** are guarding the circuit. Relay MD operates; **MD1** disconnects the time delay switch and closes a circuit for the operation of relay MS (Fig. 5); **MD2** prepares the circuit for returning ringing tone to the calling subscriber; **MD3** disconnects a possible circuit for the calling subscriber's meter; **MD4** prepares a circuit for the operation of relay F; **MD5** closes the circuit of relay J; **MD6** provides a locking circuit for relay MD; **MD7** connects Earth to the assignment switch bank. Relay J operates; **J1** prepares a circuit for the operation of the calling subscriber's meter; **J2** prepares a circuit for relay C, which is only required in the event of the calling subscriber requiring connection to a distant manual exchange; **J3** prepares a circuit for the retention of relay E. Relay MS (Fig. 5) operates and causes the operation of the ringing generator, etc. (see Para. 183).

174. Called Subscriber Free.—When the wipers have been rotated to the bank contacts of the called subscriber's line, relay E releases, since its circuit is

broken at **A2**. If the called subscriber's line is disengaged, relay **G** is not able to operate, and Earth is extended from **B2** via **G3** and **E4** to relay **K** in the called subscriber's line circuit; relay **K** operates; **K1** prepares a retaining circuit for relay **K**; **K2** closes the circuit of relay **P**; **K3** "y" disconnects Earth from the called subscriber's positive line. Relay **P** operates; **P1** closes an alternative retaining circuit for relay **K**; **P2** disconnects relay **L** from the negative line.

In the connecting link (Fig. 4), **E6** disconnects the circuit of relay **H**, which releases slowly; **H1** and **H4** re-connect the wipers to contacts **F1** and **F3**; **H2** disconnects a possible circuit for relay **H**; **H3** completes the circuit of relay **F**, which operates intermittently as contacts **YY2** and **6** close and open (see Para. 183); interrupted ringing current is now sent out to the called subscriber's line from the ringing generator via **YY1** and **5** or **ZZ1** and **4**, **F3** to the negative line, through the instrument bell and back to Earth via **F1**. Ringing current also leaks back to the calling subscriber via the .02-microfarad condenser and **MD2**, and forms the ringing tone. During the periods when relay **F** is released, relays **DA** and **DB** are connected to the negative and positive lines respectively.

When the called subscriber removes the receiver, relays **DA** and **DB** operate, during the silent period, via the telephone loop; **DA1** and **DA4** reverse the direction of the current flowing in the calling line (see Para. 180); **DA3** is concerned with junction calls from a call office (see Para. 181); **DA2** disconnects a possible circuit for relay **TM**; **DA5** disconnects the circuit of relay **MD** which releases after a short interval. **DB1** is concerned only with junction calls from a call office (see Para. 181); **DB2** and **DB5** extend the called subscriber's line to the calling subscriber's line; **DB3** disconnects the 1,300-ohm coil to relay **F**; **DB4** disconnects relays **MS** and **BY** (Fig. 5).

When relay **MD** falls away, **MD1** disconnects the circuit of relay **MS**; **MD2** disconnects the ringing tone circuit; **MD3** closes the circuit of the calling subscriber's meter; **MD4** disconnects the circuit of relay **F**; **MD5** disconnects the circuit of relay **J**; **MD6** disconnects the retaining circuit of relay **MD**; **MD7** removes an Earth from the assignment switch bank, but the connecting link is still marked engaged by the Earth via **N1**.

Relay **J** is slow-releasing and during its slow-release period, the calling subscriber's meter is operated once via the meter wire, **J1**, **MD3**, **KF6**, dm springs, driving magnet to earthed battery. It will be seen that the meter is energized only when relays **KF** and **J** are operated and relay **MD** is released; these conditions occur on local calls alone, and then only when the called subscriber removes the receiver thereby operating relay **DA**.

Relay **MS** (Fig. 5) is slow-releasing and, after an interval, falls away, thereby stopping the ringing generator, etc.

The two subscribers are now connected for conversation; current for talking purposes is fed to the calling subscriber by relay **A** and to the called subscriber by relays **DA** and **DB**.

175. Called Subscriber Engaged.—The circuit operation is exactly similar to that described in Paras. 171–173, up to the stage where the rotary magnet has rotated the wipers to the bank contacts of the called subscriber's lines. The contact in the **P** bank is earthed, as described in Para. 171.

Relay **G**, extended to the private wire at **E4**, operates to the busy Earth; **G1** closes a circuit for relay **H**; **G2** prepares a circuit for busy tone; **G3** prepares a locking circuit for relay **G**; **G4** disconnects the impulsing circuit of the rotary magnet; **G5** prepares a circuit for the operation of relay **BY** (Fig. 5); **G6** is only concerned when the call is to the 0 level. Relay **E** is slow-releasing and, when it falls away, **E4** closes the retaining circuit for relay **G**; **E2** closes the circuit of relay **BY**; **E5** closes the circuit over which busy tone is applied to the incoming positive line.

Relay **BY** (Fig. 5) operates; **BY1** and **2** close the circuit of the tone relay **BZ** and busy tone is generated in the manner described in Para. 184.

When the busy tone is heard, the calling subscriber replaces the receiver. Since relay **DA** is not operated, relay **MD** retains until relay **B** falls away owing to the release of relay **A**. When this occurs, contact **KF6** breaks before contact **MD3** makes, relay **MD** being slow-releasing; consequently, the circuit of the calling subscriber's meter is not closed. The selector is released in the manner described in Para. 176.

176. Release of the Connection.—If the calling subscriber is the first to replace the receiver, relay A releases and disconnects the circuit of relay B at A2. Relay B is slow-releasing and, during its release period, relay R (Fig. 5) is energized *via* A1 and B7. When relay B releases, the circuit of the release magnet is completed through A2, B6, N2, release magnet, R1 and 2 to earthed battery. The shaft and wipers restore to normal and relay R falls away. Relay B falls away and B2 disconnects relay KF, which releases; KF 1 disconnects relay K in the calling subscriber's equipment and the relays of the connecting link and the line equipment restore to normal.

When the selector releases, the Earth holding the K relays of both the calling and called subscribers is removed. The K2 contacts in the respective line equipments change over the circuits of the respective P relays. The P relay of the calling subscriber's equipment releases, since the telephone loop is disconnected; the P relay of the called subscriber's equipment is retained from Earth, K3 "y," positive line, and called subscriber's telephone loop, negative line, P2, K2, 7,500-ohm coil of relay P to earthed battery; P1 extends the Earth from K1 to the called subscriber's multiple thereby busying the circuit. This condition persists and the called subscriber cannot make a call until the receiver has been replaced and the circuit of relay P broken.

If the called subscriber is the first to replace the receiver, relays DA and DB release and Earth is extended *via* KF2, DB4, MD1, DA2, 1,300-ohm coil relay TM, TM2, 6,500-ohm coil of relay TA (Fig. 5) to earthed battery. Relay TA operates and the time delay switch is brought into use. If the calling subscriber does not replace the receiver within the specified period, a forced release condition is applied to the connecting link (see Para. 186).

177. If a spare number is dialled, it is necessary to return N.U. tone to the calling subscriber. All the positive lines of spare numbers on the banks are connected by straps on the connection blocks to relay DN, which operates in series with relay DB. When the wipers of a selector come to rest on the bank contacts of a spare line, DN1 closes the circuit of relay BZ so that tone is generated and DN2 connects N.U. tone to the 1,500-ohm coil of relay DN. The relay functions as an induction coil and N.U. tone is transmitted to the calling subscriber over the positive line.

JUNCTION CALLS.

178. Call to distant exchange from local subscriber.—Junctions to other exchanges terminate on the 0 level of the selectors, a group of consecutive bank contacts being allotted to the group of junctions to each exchange. In this way, for example, 5 junctions to exchange A, 3 junctions to exchange B, and 2 junctions to exchange C may have bank numbers 01—05, 06—08, and 09—00, respectively. The contacts of bank P1 on this level are extended to the connection block. The P and corresponding P1 tags of the first and intermediate lines to each exchange are strapped, the P1 contacts of the last lines being left disconnected. Thus, in the above example, the P and P1 tags of 01—04, 06 and 07, and 09 are strapped, while the P1 tags of 05, 08 and 00 are left disconnected. This condition is shown in the inset diagram contained in the bottom left hand corner of Fig. 4.

A subscriber gains access to each exchange by dialling the bank number of the first line of the required exchange. In the example given above, 01 must be dialled to call exchange A, 06 to call exchange B, and 09 to call exchange C. In the circuit description, which follows, it is assumed that the calling subscriber wishes to call exchange B.

When the calling subscriber removes the receiver, the apparatus operates in the manner described in Para. 171 up to the point where a subscriber dials the first digit, which, in this case, is 0. The wipers are stepped up to the 10th level and, as the selector shaft completes the last step, the normal post springs, NP, are operated. Relay C releases slowly, after the completion of the vertical movement and C2 prepares the rotary magnet and relay E for the reception of the next digit, which in the case under consideration is the digit 6. When this digit is dialled, the rotary magnet and relay E operate *via* A2, relay E retaining while stepping takes place. As the private wiper passes over busy lines, relay G may operate, but the circuit is guarded from interference in the manner described in Para. 173.

If the first outlet is free, then, when relay E releases at the end of its slow-release period, E4 extends Earth from B2 to the outgoing private wire. This

operation guards the connection from intrusion and closes the circuit of relay K in the junction equipment; E6 disconnects the circuit of relay H which, after its slow-release period, closes the circuit of relay F. Interrupted ringing current is sent to the distant exchange and ringing tone is returned to the calling subscriber in a similar manner to that described in Para. 174.

If the first outlet is engaged, there is an Earth on the private bank contact. The Earth is extended to the P1 contact by the strap on the connection block. Fig. 7 shows the portion of the circuit concerned in the circuit operation described in the following paragraphs. Relay G operates to the Earth *via* the private wiper during the slow-release period of relay E and, when relay E releases relay G locks to the Earth at **B2** *via* E4 and **G3**. Relay J operates from the Earth on the private wire *via* the strap on the connection block, P1 bank contact and wiper, **E1**, **G6**, R1 and **NP1**; **J1** prepares the circuit of the calling subscriber's meter; **J2** closes the circuit of relay C, which operates *via* the P1 wiper and the strap on the connection block to the busy Earth on the private wire; **J3** prepares a circuit for the rotary magnet and relay E. Relay C operates; **C3** closes the circuit of the rotary magnet and relay E; **C1** retains relay H which has commenced to release slowly; **C4** retains relay J. The rotary magnet and relay E energize; the wipers are stepped round to the bank contacts of the next line in the group and the rotary interrupter springs, R1, are opened, thereby disconnecting relay J, which releases. Relay G, extended to the private wiper *via* **E4**, is disconnected as the private wiper steps off the busy contact. With the release of relay J, **J2** disconnects relay C and **J3** disconnects the rotary magnet and relay E.

If this circuit is free, relay G is unable to operate and, when relay E falls away, the Earth from **B2** is extended to the private wiper. Relay H is disconnected and, when it falls away, extends the junction line which has been seized to contacts F1 and F3. Thereafter the circuit operation follows the lines previously described.

If this second junction line is engaged, relay G re-operates *via* **E4** to the busy Earth on the private wiper and the cycle of operations, previously described, again takes place, with the result that the wipers are stepped to the bank contacts of the next line in the group. In the case under consideration, this is the last line, since the group of junctions to exchange B consists of three lines. If the line is engaged, the busy Earth is connected to the P contact only, the P1 contact being disconnected at the connection block. Relay G operates as described above, but neither relay J nor relay C can operate because of the disconnection at the P1 bank contact. Consequently, upon the release of relay E, relay G locks *via* E4 and **G3**; relay BY (Fig. 5) is operated *via* E2 and **G5**; busy tone is transmitted to the calling subscriber *via* **G2** and E5. Release from this condition follows the principles described in Para. 176.

179. Circuit operation at the distant Exchange.—The circuit description of the manual end of the junction circuit, given in the succeeding paragraphs, applies to the "Unit, Auxillary Apparatus, No. 60," connected to C.B.S. No. 2 exchanges (Diagram AT 2025, figs 1 and 2).

The incoming ringing current received from the rural automatic exchange causes relay L to chatter *via* S1 and the 0.5-microfarad condenser; **L1** closes the circuit of relay LL, which locks through **LL2** and the C.C.B. test key to Earth; **LL1** prepares a circuit for tripping the ringing; **LL3** completes the circuit of the calling lamp.

When the operator answers, the earthed battery is connected to the ring of the cord and causes relay S to operate; **S1** completes the short-circuit across the junction, and the ringing is tripped in the connecting link at the rural automatic exchange during the next silent period following the operation of this relay; **S2** prepares the locking circuit for relay LR and connects the 1,200-ohm coil to the shunt field relay D, which, however, is not yet able to operate owing to the short-circuit across the 400-ohm coil *via* **LL1**. The operator then depresses the C.C.B. test key, and the Earth retaining relay LL is removed; **LL1** removes the short-circuit across the junction and **LL3** disconnects the calling lamp. Relay LR operates *via* the C.C.B. test key; **LR1** disconnects the 1,200-ohm coil of relay D and closes a retaining circuit for relay LR; **LR2** disconnects the 400-ohm coil of relay D and connects the 200-ohm retardation coil, IA, to relay LA. The negative line of the junction is now extended *via* **S1**, dialling key, retardation coil, **LR2**, 200-ohm coil of relay LA to Earth at the C.C.B. test key; the positive line of

the junction is connected to Earth *via* the 3,000-ohm resistance spool. In these conditions, if the call has originated at a coin collecting box (*see* Para. 181), the operator hears a discriminating tone. Relay LA operates; LA1 completes the circuit of the supervisory relay in the tip of the cord circuit to earthed battery through one coil of relay S, and the supervisory signal releases.

Upon the release of the C.C.B. test key, the Earth on the junction is replaced by a loop consisting of the retardation coil and relay LA, which remains operated. The speaking circuit is extended to the operator and the call is completed at the manual board.

Upon the completion of the conversation, the rural automatic exchange subscriber replaces the receiver and the connecting link is released in the ordinary way. The K relay, associated with the automatic end of the junction, releases; K2 changes over the circuit of relay P to the junction and this relay retains. Relay LA does not retain in these conditions; LA1 disconnects the supervisory relay of the cord circuit and the clearing signal is given to the operator. When the plug is removed, relay S releases; S1 disconnects the junction from relay LA, thus releasing the P relay at the rural automatic exchange; S2 removes the holding Earth of relay LR.

180. Call from distant exchange to rural automatic exchange subscriber.—

In the circuit description given in the following paragraphs, it is assumed that the call is being made from a C.B.S. No. 2 exchange; Diagram AT. 2025, Figs. 1 and 2 refer. The operator plugs into the jack and relay S operates *via* the ring of the cord circuit; S1 closes a loop across the junction through the 400-ohm coil of relay D and relay LA; S2 completes the circuit of the 1,200-ohm coil of relay D. In these conditions, relay D operates; D1 disconnects the tip of the cord circuit so that a clearing signal is given.

The loop across the junction operates the calling equipment at the rural automatic exchange similarly to that which takes place when a local subscriber removes the receiver (*see* Para. 171) and a connecting link is seized. The operator at the manual exchange operates the dialling key and dials the two digits required. While the dialling key is operated, relays LA and D release and, in these conditions, the clearing signal continues. The connecting link at the rural automatic exchange operates in the normal way and interrupted ringing current is connected to the required subscriber's line.

When the subscriber removes the receiver, the operation of relay DA in the connecting link reverses the direction of the current flowing in the junction line; the direction of the current in the 400-ohm coil of relay D at the manual exchange is consequently reversed, and relay D is released but relay LA is retained. The circuit of the supervisory relay in the cord circuit is completed through one coil of relay S, and the clearing signal is removed.

When the conversation is completed, the rural automatic exchange subscriber replaces the receiver and relays DA and DB in the connecting link release. The current flowing in the junction line is reversed once again, with the result that relay D at the manual exchange re-operates; D1 disconnects the supervisory relay and the clearing signal is given. The release of relays DA and DB in the connecting link causes the time delay switch to be started; if the operator removes the plug before forced release is applied to the connecting link, the apparatus at the rural automatic exchange releases as described in Para. 176; should forced release be applied to the connecting link, the P relay associated with the junction at the rural automatic exchange locks over the junction line. Relays LA and D at the manual exchange release in the manner described in Para. 179, and the clearing signal continues.

It may be seen that, on calls from the rural automatic exchange to the manual exchange, relay LA controls the cord circuit supervisory signals, while, on calls from the manual exchange to the rural automatic exchange, the supervisory signal is controlled by relay D. In the latter case, relays LL and LR are not brought into use.

181. Coin Box Lines.—In order that coin box facilities may be provided at the rural automatic exchange, it is necessary for the operators at the distant manual exchanges to be provided with means of discriminating between calls from ordinary subscribers and calls from coin box subscribers.

The L1 contacts of ordinary subscribers' circuits are connected directly to Earth, but those of coin box subscribers pass through the 3-ohm coil of a retardation

coil to Earth as shown by the dotted connection on Fig. 3. When a distant exchange receives a call over a junction from a rural automatic exchange, the operator plugs into the answering jack and depresses the C.C.B. test key. The negative line of the junction is earthed *via* relay LA and the retardation coil, while the positive line is earthed *via* a 3,000-ohm resistance spool in the manner described in Para. 177. This operation causes relay DB at the rural automatic exchange to release, while relay DA retains to the Earth applied to the negative line at the manual exchange; DB2 and DB5 (Fig. 5) disconnect the circuit to the calling subscriber; DB4 completes a circuit *via* MD1 and **DA2** for relay BY, which operates and causes tone to be generated. The tone is connected to the 300-ohm coil of the retardation coil, RC (Fig. 3), and is induced in the 3-ohm coil. If the calling line is a coin box line, tone is transmitted *via* L1, P1 bank contact and wiper, 0.25-microfarad condenser, DB1, **DA3**, H4 and **B4** to the negative line of the junction, thence *via* the cord circuit to the operator's telephone. Absence of tone indicates that an ordinary subscriber is calling.

The necessity for two digits to be dialled for a call to a distant manual exchange from a rural automatic exchange, requires a modification to the "Telephone No. 123." The diagram in Fig. 8 illustrates the modification. When the digit 0 is dialled, the auxiliary contact springs on the dial break, thereby removing a short-circuit across relay SR, which operates; **SR1** removes the short-circuit across the impulsing springs and **SR2** prevents the short-circuit across relay SR being replaced when the dial returns to the normal position. The continued operation of relay SR allows a second digit to be dialled.

COMMON APPARATUS.

182. The Relay Timing Group.—It has been shown that, when a call is originated, relay KF operates; **KF2** closes a circuit *via* the 1,300-ohm coil of relay TM for the operation of relay TA (Fig. 5). Relay TA operates and relay TM (Fig. 4) remains normal; **TA1** prepares a circuit for the driving magnet of the time delay switch; **TA2 and 3** close a circuit for the operation of relay TD. **TD1 and 2** prepare a circuit for the driving magnet of the time delay switch; **TD 3 and 5** connect Earth to the relay timing group.

At the instant when Earth is applied to the relay timing group, the circuit of each of the relays X, Y and Z is completed. As it is a practical impossibility to obtain three relays which have identical operating lags, one of these three relays is the first to operate. Suppose relay X operates; **X 1 and 2** disconnect relay Z; relay Y operates and **Y1 and 2** disconnect relay X, which releases after a short interval and completes the circuit of relay Z. Relay Z operates and disconnects relay Y, which releases after a short interval and completes the circuit of relay X. Relay X operates and disconnects relay Z, which releases after a short interval and reconnects relay Y. Relay Y operates and disconnects relay X. Thus the cycle continues. Since each relay is slow-releasing, the period during which each one is operated is the releasing time of one of the other two relays plus its own releasing time. The auxiliary relays XX, YY and ZZ are each operated in turn with relays X, Y and Z, and they are energized for approximately one-third of the time taken by the complete cycle since they are fast-releasing relays. The three relays XX, YY and ZZ control the ringing current, the busy tone and the time delay switch.

183. Ringing current is generated when relay MS operates as the subscriber dials the second digit; **MS1 and 3** supply Earth to the pendulum magnet while **MS2 and 4** supply Earth for the relay timing group. Contacts XX1 and XX4 are operated intermittently as described in Para. 182 and, upon their operation, the circuit of the 300-ohm pendulum magnet is completed. The magnet attracts the pendulum and holds it until contacts XX1 and XX4 release. The pendulum is then released but, owing to the inertia of its bob, oscillates between the contacts on either side and completes, in turn, the circuits of the 49-ohm coil and the 54-ohm coil of the transformer from Earth, **MS1 and 3**, XX1 and XX4, 49-ohm or 54-ohm winding, pendulum contact **RV1**, 5-ohm retardation coil CC, to earthed battery. The 49-ohm and 54-ohm windings, together with the 59-ohm winding, are wound in a transformer so that an alternating current of about 16 cycles per second, suitable for ringing magneto bells, is generated by induction in the 59-ohm winding as the pendulum oscillates. Before the

oscillations die down, contacts XX1 and XX4 close once again and attract the pendulum; upon release, the pendulum again oscillates.

The ringing current is supplied to connecting links 1 and 3 by contacts **YY1 and 5** and to connecting links 2 and 4 by **ZZ1 and 4**. **YY2 and 6** operate the F relays in connecting links 1 and 3, while **ZZ2 and 3** operate the F relays of connecting links 2 and 4; thus the ringing current is extended to the selector wipers and thence to the called subscriber's line.

184. Tones.—Tone is generated by the differential buzzing relay, BZ. When relay BY or relay DN operates, a circuit is completed *via* **BY1 and 2** or **DN1, BZ1**, one coil of relay BZ, 100-ohm retardation coil to earthed battery. Relay BZ operates and **BZ1** removes the short-circuit from the other winding of the relay. Current now flows through both windings, but, as the magnetic effect of each is equal and opposite, the relay releases. This restores the original condition and the relay re-operates. This cycle of operations recurs rapidly and a tone of approximately 400 p.p.s. is produced.

The continuous tone is used for coin box discrimination tone and for N.U. tone in the case of spare numbers. After being transmitted through the .04-microfarad condenser, it is interrupted by contacts XX2 and 3 in the ratio of one second tone, one half second silence and forms the busy tone.

185. The Time Delay Switch.—If, for any reason, a connecting link is seized but the call is not completed, the time delay switch operates and applies a forced release condition to the link after a minimum period of from 12 to 25 seconds. The switch is brought into operation on all calls but it is normally disconnected before the forced release condition is applied. Hence, any conditions which cause relay KF to be operated while relays DB, MD and DA are released bring in the forced release condition after the specified time has elapsed.

When relay KF operates, **KF2** closes the circuit *via* DB4, MD1, DA2, 1,300-ohm coil of relay TM, TM2, 6,500-ohm coil of relay TA to earthed battery. Relay TA operates as described in Para. 182, but relay TM will not operate in series with 6,500-ohms; **TA2 and 3** close at the circuit of relay TD which operates. **TD3 and 5** start the relay timing group; **TD1 and 2** prepare a circuit for the driving magnet of the time delay switch. When relay YY operates, this circuit is closed and the driving magnet energizes. Upon the release of YY3 and 4 the driving magnet is de-energized and the wipers, presuming that they start from the first bank contacts, step to the second bank contacts. When contacts YY3 and 4 close, the driving magnet is again energized and, upon release, steps the wipers to the third bank contact. The 100-ohm coil of relay TA is now in parallel with the 6,500-ohm coil *via* the wiper and third bank contact of the second arc of the time delay switch. The reduction in resistance causes the operation of relay TM in the connecting link, and the relay locks *via* **TM2** (Fig. 4) in series with the 100-ohm coil of relay TA. Contacts YY3 and 4 release and re-operate with the result that the wipers are stepped to the fourth bank contact.

The wipers of the time delay switch are stepped in this manner at intervals of about one second, until they reach the twelfth bank contacts. Earth is now applied from the wiper and bank contact of the first arc, *via* the bank wiring and the connection block, **TA1**, dm springs to the driving magnet. This circuit forms a self drive circuit for the driving magnet and the wipers are stepped rapidly until they again reach the first bank contacts. Earth is now applied *via* the wiper and first bank contact of the first arc of the time delay switch and **TM1** to relay B of the connecting link. Since **A2** is connecting Earth to the other side of this relay, it is short-circuited and releases after a short interval. The wipers of the time delay switch are stepped to the second bank contacts over the circuit *via* **YY3 and 4**, and Earth is applied to the second bank contact of the first arc. The circuit of the release relay is closed by **TM3** in the connecting link (Fig. 4), and the selector and all relays are released; when relay KF releases, the circuit of the time delay switch is broken at **KF2**.

It may be seen that it is only possible to operate relay TM when the wipers of the time delay switch are resting on the third bank contacts. As a result, it follows that, if the switch is started when its wipers rest on the fourth or subsequent bank contacts, relay TM is not operated until the wipers have been rotated to the third bank contacts. The wipers must rotate again before Earth can be applied to relay

B, consequently the wipers have to step over more or less contacts according to their starting position, and the delay period may vary between 12 and 25 seconds.

The period of delay may be altered by changing the connections on the connection block, below the time delay switch, so that the automatic stepping circuit of the driving magnet may be brought in sooner or later as desired. The minimum period is approximately from 12 to 25 seconds and the maximum approximately 31 to 62 seconds.

186. Calling Subscriber's mis-operation.—(a) *The receiver left off the switch-hook* produces the same ultimate effect whether the receiver is left off before dialling or after conversation is completed. A connecting link is seized in the usual way and **KF2** starts the time delay switch. After an interval of 12 to 25 seconds (see Para. 185) relay B is short-circuited by the Earth *via* **TM1**. Relay B releases after an interval and the connecting link is released as described in Para. 185. Relay K in the subscriber's line equipment is disconnected at **KF1** and releases; the circuit of relay P, which was retained *via* **K2**, is changed over to the subscriber's negative line *via* the telephone and to Earth at **K3** "y." Hence, the only relay in use is the high resistance relay, P, which remains operated as long as the receiver is left off the switch-hook; **P1** extends Earth from **K1** to the subscriber's multiple contact thereby busying the line. When the subscriber replaces the receiver relay P releases and the line may again be used.

(b) *Subscriber dials one digit only.* In this case relay MD is not operated, so that the time delay switch is still operating *via* **KF2**, **DB4**, **MD1** and **DA2**; forced release conditions are applied after an interval of from 12 to 25 seconds as described in the preceding paragraph. It will be seen that the second digit must be dialled within from 12 to 25 seconds after the removal of the receiver.

187. Line Faults.—(a) *Permanent loop.*—Provided that the loop is of sufficiently low resistance to allow relays L and A to operate, the operation of the apparatus is similar to that occurring when a subscriber removes the receiver and does not dial (see Para. 186(a)).

(b) *Negative line Earth.* Since this condition causes the operation of relay L, and when the line finder has found the circuit, operates relay A over one coil, the fault produces the same effect as a permanent loop.

(c) *Positive line Earth* does not interfere with the operation of relay L. When relay A is seized, one coil is short-circuited, but the relay may work quite satisfactorily over lines of average resistance. Should tone be connected, the calling subscriber does not receive it as it goes to Earth before reaching the subscriber's telephone. The subscriber might be able to use the line for outgoing calls. On incoming calls, relay DB of the connecting link is short-circuited. The speaking circuit is broken at **DB2** and **DB5**. If the calling line is a coin box circuit, coin box discrimination tone is connected to the called subscriber by **DB1**. Relay BY retains *via* **DB4** so that the tone apparatus continues to operate.

188. Provisions against breakdown.—In an unattended automatic exchange it is very necessary that all common apparatus shall be reasonably fault-proof and that common apparatus shall not be held or be prevented from working correctly owing to faulty subscribers' circuits.

It is impossible to make provision against all faults which may arise, but it is quite practicable to prevent a breakdown of service which may be caused by the more common faults to which the apparatus is liable. To this end, all the more important contacts in the common apparatus are made of platinum and are duplicated. In the circuit description given herein, all duplicated contacts appear as, for example, **ZZ2** and **3**. Provision is made against blown connecting link fuses and a certain fault which may occur on subscribers' line equipments.

(a) *Blown connecting link fuses.* When a connecting link fuse blows, the spring on the underneath side makes contact with the alarm bar and prepares the circuit of the 1,000-ohm coil of relay F in the selector. When relay SB (Fig. 4) is operated by a calling subscriber, **SB2** closes the circuit of relay F *via* the 100-ohm coil of relay FA (Fig. 5); relay F operates and **F2** connects Earth to the assignment switch bank contact associated with the faulty connecting link. The driving magnet of the assignment switch operates to this Earth *via* its interrupter springs and the wipers are stepped on, so that the faulty connecting link is not seized.

(b) *Subscriber's line equipment fault.* If the **L1** contact of a subscriber's line equipment becomes faulty, Earth is not connected to the **P1** bank contact of the

line finders. Another subscriber, upon lifting the receiver, causes a line finder to hunt. If the wipers arrive at the calling subscriber's bank contact before the faulty line is encountered, the connection proceeds normally. Should the faulty line be found first, relay KF operates since it is no longer short-circuited; **KF3** and **KF4** connect the positive and the negative lines to relay A, but the relay does not operate owing to the fact that the subscriber on the faulty line is not calling; **KF7** operates relay AX *via* **SF3**. Relay SF releases after a short interval and a circuit is completed for the driving magnet of the line finder which operates from Earth, **SA1**, **AX3**, wiper and bank contact of the assignment switch, B1 and SF1. Relay AX releases after a short interval, and the driving magnet of the line finder is disconnected with the result that the wipers are stepped to the next bank contacts. The circuit of relay KF is broken at SF5 and, upon the release of relay AX, the circuit of relay SF is again completed; relay SF re-operates and **SF4** "x" closes the hunting circuit of the line finder driving magnet, which now receives Earth from the P1 wiper and continues stepping on in the process of finding the calling subscriber's line.

189. Fault Test Circuit.—In order that the operators at the distant manual exchanges may verify that the rural automatic exchange apparatus is free from certain faults, a special testing facility is provided. The distant operator dials a certain number—99 is the one usually employed—and the positive wiper of the selector is connected *via* the bank contact of the number to relay FT; relays FT and DB operate; **FT4** closes the circuit of the 1,500-ohm coil of relay FT, which functions as an induction coil; **FT3** retains relay MS and **FT5** retains relay BY, so that ringing current and tone are generated.

(a) *Equipment O.K.* If none of the under-mentioned faults exist, the operator hears interrupted ringing tone in the ratio of one second tone: one half-second silence transmitted *via* the 0.5-microfarad condenser, FA1 and 2, RA1 and 2, **FT4** to Earth through the 1,500-ohm coil of relay FT, whence it is induced to the 500-ohm coil of the relay and thence to the line.

(b) *Ringing failure.* In the event of failure of the ringing, the tone is absent.

(c) *Relay timing group failure.* The tone is absent or irregular according to the fault.

(d) *Blown fuse.* Should a fuse be blown, relay FA operates *via* the fuse alarm bar, **FT1** and the 100-ohm coil of relay FA or **FT2** and the 1,000-ohm coil of relay FA; **FA1** and **2** connect N.U. tone to the 1,500-ohm coil of relay FT and the tone is transmitted to the operator.

(e) *Failure of a selector to release.* In this case the vertical off-normal springs of the selector are closed; **FT6** closes the circuit for the operation of relay RA; **RA1** and **2** cause N.U. tone to be sent out.

(f) *Charging plant failure.* Should the charging plant fail before being automatically stopped by the ampere-hour meter on the power panel, contact FT7 is connected to Earth. When the test call is made, **FT7** closes the circuit of the second coil of relay RA and N.U. tone is transmitted.

APPENDIX I.

LIST OF STANDARD DIAGRAMS.

<i>Diagram No.</i>	<i>Title.</i>
A.T. 67 -	- R.A.Xs. Line test case. Testing circuit.
„ 814 -	- Auto Manual Positions and C.B. Exchanges. Transfer Junction.
„ 2002 -	- Panel, charging, No. 20.
„ 2018 -	- R.A.Xs. Wiring of Power Plant. Petrol engine charging set.
„ 2019 -	- „ „ „ „ Tungar rectifier charging set.
„ 2020 -	- „ „ „ „ Dynamotor charging set.
„ 2022 -	- „ Explanatory diagram of power plant.
„ 2025 -	- Bothway lines to R.A.Xs., explanatory diagram.
„ 2026 -	- Unit, Auxiliary Apparatus No. 60, wiring diagram.
„ 2028 -	- Telephone No. 123 modified. Explanatory, diagram.
„ 2029 -	- „ „ „ „ Wiring diagram.
„ 2035 -	- R.A.Xs. Test case for testing automatic equipment.
C.B.S. 589 -	- Magneto exchanges. Transfer circuit.
„ 638 -	- C.B.S. Nos. 1 and 2 exchanges. Jack-ended transfer circuit.
E.C. 1231 -	- M.D.F. $\frac{0}{240}$ Arrangement of apparatus.
„ 1272 -	- M.D.F. Method of connecting cables and jumpers.
„ 1341 -	- R.A.Xs. Cable and jumper scheme.
„ 1345 -	- R.A.Xs. View of unit I.D.F.
„ 1349 -	- Kiosks Nos. 1 and 3.
„ 1352 -	- Connectors, battery, for 40 A.H. Cells.
Exch. Sk. 3732 -	- Rural Auto. Exchange. Layout of equipment.
T.K. 1329 -	- Trunking diagram of R.A.X.
Misc. 3056 -	- R.A.Xs. Building details for petrol engine charging set.
„ 3057 -	- R.A.Xs. Details of erection of petrol engine charging set.
„ 3421 -	- R.A.Xs. Parent Exchange Terminations.

APPENDIX II

SCHEDULE OF MAIN ITEMS

No.	Item.	Drawing No.	Quantity, Purpose and Location.	How obtained.	Remarks.
1	"Unit, Auto, No. 5 "	-	Detailed in Text of Instruction- - -	Reqn. via E.-in-C. -	Name of Exchange to be stated. -
2	"Frame, M.D. $\frac{0}{240}$	-	" " " " - - -	Rate Book Item -	-
3	"Protectors, HC & T, 40B "	-	" " " " - - -	" " " " -	-
4	"Fuse, Mtgs., No. 4002 "	-	" " " " - - -	" " " " -	-
5	"Strips, Fanning, 40 line "	-	" " " " - - -	" " " " -	-
6	Loose Pedestal, 1' 6" wide, 2' 0" deep, 2' 7" high.	-	" " " " - - - One Cupboard required, locate in corner just inside door at right-hand side. Face towards power board. To accommodate :— (a) Spare heat coils, fuses, carbons and jumper wire. (b) Power plant spares, tools, log books and cleaning equipment. (c) Auto apparatus tools. (d) " " spare parts. (e) Circuit diagrams. Note.—Tools, spare parts and other similar items should be wrapped in dry chamois leather, "Selvyt" cloth or other suitable material to prevent rusting and oxidation.	Requisition direct from Office of Works.	Top to be covered with brown linoleum. (See Item 11.)
7	Mat, Door, Fibre, No. 2 27" × 16".	-	-	" " " "	-
8	Extincteur, Petrolex - -	-	One. Stand on floor by battery rack just inside door.	" " " "	See Para 96.
9	Card Index Box, Steel, 8" × 5", with compressor.	-	One, to accommodate :— (a) List of subscribers' names and addresses, also telephone Nos., Apparatus and Cable pairs. (b) Allocation of selector multiple Nos. to subscribers and junctions. (c) M.D.F. records of leading-in cable pairs D.P. plan, etc.	" " " "	-

APPENDIX II.—continued.

No.	Item.	Drawing No.	Quantity, Purpose and Location.	How obtained.	Remarks.
10	Chair, Windsor	F.S. 159	One, General purposes	Requisition direct from Office of Works.	—
11	Linoleum (Standard Brown)	—	As required to cover floor. (Not to be laid until installation finished and interior painting completed.)	" " "	See Para. 30.
12	Soft Sweeping Broom	—	One. General purposes	Local purchase	—
13	G.I. Pail—small	—	One. General purposes	" " "	—
14	" Mat. I.R. 24" × 30" "	—	One. To stand upon when making adjustments on Public Supply side of power plant.	Rate Book Item	Required only when a Dyno. motor or rectifier is fitted
15	" Labels, No. 116 "	—	As required. To label all meters working on subs. lines or junctions.	" " "	—
16	" Blanks, meter "	—	As required. To be fitted under covers of spare meters.	" " "	See Para. 105 (b)
17	" Case, Test, D 9262 "	AT. 67	One. To be fitted at end of M.D.F. General testing on subs. lines, etc.	" " "	See Para. 52.
18	" Tester, No. 82 "	AT. 2035	One. Portable. For testing Auto. Apparatus	" " "	See Para. 54.
19	" Cells, Dry, Z "	—	<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> 4 4 2 As reqd. 2 </div> <div style="font-size: 3em; margin-right: 10px;">}</div> <div> For general lighting - - - - - - - - - - - - - - - </div> </div>	Rate Book Items.	—
	" Spools, Res. No. 1—4 ohms "	—		—	See Para. 51.
	" Switch, Tumbler, No. 1 "	—		—	
	" Cable, E.F. & P., 1 pr/10 "	—		—	
	Lamps—2 volt—0.25 Amp. Pocket Flash Lamp Type Screw Type Holder and Reflector for above.	—		Purchase locally.	
20	" Fuses 5/1 " "	—	12 for Each Unit (not including spares)	Rate Book Item	—
21	" Labels, No. 88, White "	—	4 per unit. To indicate Connecting Link Number on Selectors.	Rate Book Item	See Para. 103.

APPENDIX III

LIST OF POWER PLANT ITEMS.

SCHEDULE 1.

Plant equipped with Petrol Engine battery charging set.

<i>Item.</i>	<i>Quantity.</i>
Cells, Secondary, Stationary, No. 5. - - - -	50
Insulators, Battery, No. 8 - - - -	200
Acid, Sulphuric, No. 3 - - - -	23 gallons.
Oil, Insulating, No. 3 - - - -	5 pints.
Hydrometers, No. 9 - - - -	2
Thermometers, No. 1 - - - -	2
Panel, Charging, No. 20; includes Ampere-hour meter and fuses and the following accessories :—	
8 Cables E.L.V.I.R. 250 volts, .0225 sq. inch marked G.P.K.O.H.J.L. & M. on diagram A.T.2018 and equipped with cable ends ready for service.	
2 Lead plated copper battery strips to Drawing Misc. 2963, Figure 1.	
2 Lead plated copper battery strips to Drawing Misc. 2963, Figure 2.	
2 Battery fuse mountings to Drawing Misc. 2963 Figure 3.	
1 Petrol Engine battery charging set 50/68 volts, 10/8 amperes, 500 watts, which includes the Engine pier, water tank, silencer, petrol valve, piping, foundation bolts, petrol tank, filter, wall box, spare parts and tools.	
Casing and Cover T.4 - - - -	35 ft.
Compound, Anti-Freezing - - - -	6 gallons
(See T.I. XXIV Para. 23. Allowance has been made for 1 to 4 mixture.)	
Fuses No. 21/20 for spares - - - -	2
" " 20/10 " " - - - -	1
" " 1/1 " " - - - -	2
Cable, E.L., I.R.V. core, 250 volts, single, .002 square inch - -	15 yards
Wire, copper, soft, 3/20 strand - - - -	8 yards

SCHEDULE 2.

Plant equipped with Tungar Rectifier battery charging sets.

<i>Item.</i>	<i>Quantity.</i>
Cells, Secondary, Stationary, No. 5 - - - -	50
Insulators, Battery, No. 8 - - - -	200
Acid, Sulphuric, No. 3 - - - -	23 gallons.
Oil, Insulating, No. 3 - - - -	5 pints.
Hydrometers, No. 9 - - - -	2
Thermometers, No. 1 - - - -	2
Panel, Charging, No. 20. (For details, see Schedule 1.) - - - -	1
Rectifier, Tungar, No. 1 - - - -	1
Box, Service, E.L., No. 1 - - - -	1
Cable, E.L., I.R.V. Core, 250 volt, single, .01 sq. inch - -	10 yards.
Stool, No. 2 - - - -	1
Casing and Cover T.4 - - - -	32 feet.
Fuses, No. 21/20 for spares - - - -	2
" " 20/10 " " - - - -	2
" " 1/1 " " - - - -	2
Wire, Copper, Soft, 3/20 strand - - - -	8 yards.

SCHEDULE 3.

Plant equipped with Dynamotor Charging Set.

Particulars as per Schedule 2 except that a Dynamotor No. 8 52/62 Volts 7.2/4.5 amperes replaces the Rectifier, Tungar, No. 1.

SCHEDULE 4.

General.

Secondary Cell Log Book T.E. 1122.

Preventive Stores (see T.I. XXIV. Para. 49). Accommodate the stores on a small shelf fixed to the end wall just inside the door near to the battery rack.

Card T.E. No. 153 to be fitted in a small glazed frame (provided locally) and fixed to the wall over the shelf.

Card T.E. 764 placed in a suitable glazed frame (provided locally) should be fixed adjacent to the power board when a Dynamotor battery charging set is used, and card T.E. 766 when a Tungar Rectifier is used.

At Exchanges where the Petrol Engine battery charging set is used, a typed card of instruction, as follows, should be placed in a suitable glazed frame (provided locally) and fixed adjacent to the power board.

“ POST OFFICE ENGINEERING DEPARTMENT.”

“ PETROL ENGINE CHARGING SET. INSTRUCTIONS FOR OPERATION.”

PRELIMINARY.

Pour into the petrol tank a sufficient quantity of “ Petroil ” for the Charge.

Note.—“ Petroil ” is a mixture of petrol and oil (oil Vacuum “ A ” or Castrol “ AA ” is suitable); a quarter pint of oil to be added to every gallon of petrol and mixed well before pouring into the petrol tank.

Set the pointer of the ampere hour meter No. 1, by means of the key provided, to the reading on the dial corresponding to the “ Charge ” (ampere hours) to be put into the battery (see Secondary Cell Instructions).

Verify the mechanical action of the Petrol Valve and “ No Load ” release relay.

See that the switches on the power panel are clean and slightly greased with vaseline to ensure correct operation and to prevent corrosion.

See that the water tank is full.

STARTING.

Place the tumbler switch in the starting position (Panel, charging, No. 20). Open the petrol valve.

Turn the petrol on and flood the carburettor. Give a few slow turns with the starting handle. Then give one or two sharp turns, repeating two or three times if necessary. The engine should start.

Place the ammeter switch to charge.

Close the charge switch and no load release relay.

Place the tumbler switch in the running position.

Charging should then commence.

REGULATION.

Ordinary Recharge.

Regulate the throttle and, if necessary, the field rheostat so that the charging current is equal to the ampere hour capacity of the battery divided by 7.

Equalising or initial charging.

Regulate the throttle and the field rheostat, if necessary, so that charging current is equal to the value laid down in the Secondary Cell Instructions.

APPENDIX IV

Tools for use in connexion with the Maintenance of Rural Automatic Exchanges
(Unit Auto. No. 5), G.E. Co.'s type.

Rate Book Description. (1)	Particulars. (2)	Quantity. (3)
Tool, Instrument:		
No. 14 - - -	Pliers for removing heat coils A and B - - -	1
„ 40 - - -	Pliers for removing meter covers - - -	1
„ 85 - - -	Short straight duck bill pliers for light spring adjustment - - -	1
„ 91 - - -	Screwdriver, $2\frac{1}{2}'' \times \frac{1}{8}''$ - - -	1
„ 93 - - -	„ $2\frac{1}{2}'' \times \frac{1}{4}''$ - - -	1
„ 96 - - -	„ $8'' \times \frac{9}{32}''$ - - -	1
„ 104 - - -	Pliers, fine taper, for light spring adjustments, dials, &c. - - -	1
„ 106B - - -	D.E. flat spanners, length $2\frac{3}{4}''$, for nuts $\frac{7}{32}''$ and $\frac{1}{4}''$ - - -	1
„ 106C - - -	D.E. flat spanners, length $3\frac{1}{8}''$, for nuts $\frac{9}{32}''$ and $\frac{5}{16}''$ - - -	1
„ 106D - - -	D.E. flat spanners, length $3\frac{1}{2}''$, for nuts $\frac{11}{32}''$ and $\frac{3}{8}''$ - - -	1
„ 106E - - -	D.E. flat spanners, length $3\frac{7}{8}''$, for nuts $\frac{13}{32}''$ and $\frac{7}{16}''$ - - -	1
„ 108A - - -	For hexagonal nuts $\frac{1}{4}''$ and $\frac{9}{32}''$ between flats -	1
„ 108B - - -	„ „ $\frac{5}{16}''$ „ $\frac{11}{32}''$ „ „ -	1
„ 108C - - -	„ „ $\frac{3}{8}''$ „ $\frac{13}{32}''$ „ „ -	1
„ 109 - - -	Spring tommy for above - - -	1
„ 120 - - -	Bank contact cleaner - - -	1
„ 122 - - -	Relay spring contact adjuster offset, with 20 mils slot - - -	1
„ 123 - - -	Selector wiper adjuster - - -	1
„ 125 - - -	Feeler gauges, in case, for relay contact adjustment. (Not to be used for rotary line switch magnet armature adjustment.)	1
„ 126 - - -	Spring adjuster for selector cam springs (11th contact), &c. - - -	1
„ 127 - - -	Selector double dog bender - - -	1
„ 132 - - -	Remote spring adjuster - - -	1
„ 137 - - -	Relay spring contact adjuster, offset, with 35 mils slot - - -	1
„ 143 - - -	Hex. "T" box spanner for adjusting magnet glands of selectors - - -	1
„ 146 - - -	Forked screwdriver for relay fixing nuts - - -	1
„ 151 - - -	Relay spring contact adjuster - - -	1
„ 152 - - -	Spring and buffer adjuster - - -	1
„ 155 - - -	Contact cleaner - - -	1
„ 157 - - -	Set of thickness gauges for distancing relay springs - - -	1
„ 160 - - -	Lever for adjusting right and left hand spring sets on relays - - -	1
„ 161 - - -	Insulators for switch and relay contacts - - -	6
„ 164 - - -	Bender for adjusting tension of preselector wipers - - -	1
„ 173 - - -	Cranked spanner for $\frac{9}{32}''$ nuts for adjusting vertical magnet core screws of selector, used with Tool, Inst., No. 174 - - -	1
„ 174 - - -	Cranked spanner for $\frac{3}{8}''$ nuts for adjusting vertical magnet glands of selectors, used with Tool, Inst., No. 173 - - -	1

Rate Book Description. (1)	Particulars. (2)	Quantity. (3)
No. 175 - - -	Adjusting tool for rotary interrupter arm of selector - - - - -	1
„ 177 - - -	Adjusting tool for contact breaker arm of preselector - - - - -	1
„ 183 - - -	Set of 2 pressure gauges, 0-60 and 0-200 grammes for relay adjustment - - -	1
„ 186 - - -	Claw type relay contact spring adjuster -	1
„ 205 - - -	Cranked spanner for pawl stop screws, &c., for rotary line switch - - - - -	1
Bits, Soldering, Instrument, small tip -	For use on bank multiples - - - - -	1
Ovens, Soldering -	For use with fuel Meta - - - - -	1
Lamps, Headgear, No. 2 -	2 spare "Lamps No. 8—55 V." To be held	1
Tester, No. 23 - - -	(Testing lamp) - - - - -	1

APPENDIX V

Tools suitable for men employed in the Maintenance of Automatic Subscribers' Apparatus.

Rate Book Description. (1)	Particulars. (2)	Quantity. (3)
Bag, Leather - - -	- - - - -	1
Pliers, Flat-nosed, 5" -	- - - - -	1
Tool, Instrument:		
No. 79 - - -	Box spanner $4\frac{1}{2}" \times \frac{3}{16}"$ between flats - -	1
„ 91 - - -	Screwdriver, $2\frac{1}{4}" \times \frac{1}{8}"$ - - - - -	1
„ 93 - - -	„ $2\frac{1}{2}" \times \frac{1}{4}"$ - - - - -	1
„ 94 - - -	„ $6" \times \frac{5}{32}"$ - - - - -	1
„ 96 - - -	„ $8" \times \frac{9}{32}"$ - - - - -	1
„ 98 - - -	Bender for key springs on lever keys - -	1
„ 99 - - -	„ „ relay springs - - - - -	1
„ 103 - - -	Nippers, side cutting - - - - -	1
„ 106B - - -	D.E. flat spanner, length $2\frac{3}{4}"$, for nuts $\frac{7}{32}"$ and $\frac{1}{4}"$ - - - - -	1
„ 106C - - -	D.E. flat spanner, length $3\frac{1}{8}"$, for nuts $\frac{9}{32}"$ and $\frac{5}{16}"$ - - - - -	1
„ 108A - - -	D.E. box spanner, tubular, $4\frac{1}{2}"$ for hexagonal nuts, $\frac{1}{4}"$ and $\frac{9}{32}"$ between flats - - -	1
„ 155 - - -	Contact cleaner - - - - -	1
Detector, No. 2, complete - - -	- - - - -	1
Coil, Testing, No. 1 -	- - - - -	1
Case, Contact Cleaner -	- - - - -	1
Duster - - -	- - - - -	1
Bit, Soldering, Instrument, straight -	- - - - -	1
Bit, Soldering, Instrument, small -	- - - - -	1
Scissors, $4\frac{3}{4}"$ - - -	- - - - -	1
Hammer, Stapling -	- - - - -	1
Spanner, quick grip -	- - - - -	1
Bradawl, $\frac{1}{16}"$ - - -	- - - - -	1
File, Hand, flat, smooth, 4" - - -	- - - - -	1

APPENDIX VII

List of Abbreviations for use on Fault Records.

A. -	Alarm	H.C. -	Heat coil
Adj. -	Adjusted	H.G.Rec.-	Headgear Receiver
Adv. -	Advised	H.M.T. -	Hand Micro. Tele.
A.N. -	Advice Note	H.R. -	High Resistance
Arm. -	Armature		
A.S. -	Assignment switch	I.D.F. -	Inter. Distb. Frame
Auto. -	Automatic	I/J. -	Incoming Junction
		Imps. -	Impulses
B. -	Bank	Inc. -	Incoming
B.B. -	Busy Back	Indr. -	Indicator
B.B.R. -	Back Bridge Relay	Induc. -	Induction
B.Con. -	Bank Contact	Int. -	Intermittent
Bd. -	Board	Inter. -	Interrupter
Bkn. -	Broken	Inter.Spg. -	Interrupter spring
B.P. -	Breast plate	Intl. -	Internal
B/W -	Bothway		
Bz. -	Buzzing	J. -	Junction
		JE/J -	Jack ended junction
C. -	Current	Jpr. -	Cross Connections— (Jumper wire)
C.C. -	Clear Chute (of C.C. Box)	Ld. -	Load
C.C.B. -	Coin Collecting Box	L.F. -	Line Finder
Cct.-	Circuit	L.G. -	Lamp Glowing
C.D.H. -	Cable Distribution Head	L.I. -	Low Insulation
Cd. -	Code	L.L. -	Line Lamp
C.F. -	Cord Cct. Faulty	L.R. -	Line Relay
C.G.Nos. -	Can't get Numbers	L.T. -	Local Transfer
C.G.X. -	Can't get Exchange	Lub. -	Lubricant
Chgd. -	Changed	Lv. -	Level
C.L. -	Connecting Link	L.Wpr. -	Line Wiper
Cld. -	Cleared		
Clnd. -	Cleaned	M. -	Magnet
Con. -	Contact	Manl. -	Manual
Con.D. -	Contact Dirty	Mech. -	Mechanism
Cond. -	Condenser	M.D.F. -	Main Distg. Frame
Condr. -	Conductor	M.N.R. -	Meter not registering
C.O.R. -	Cut off Relay	Mp. -	Mouthpiece
Cont.Rot. -	Continuous Rotation	Mp.B. -	Mouthpiece broken
C.S.H. -	Called sub. held	M.Spg. -	Main Spring
		Mult. -	Multiple
Dis. -	Disconnection		
Dl. -	Dial	N. -	Noisy
Dub.Con. -	Double Connection	N.A. -	Night Alarm
		N.C. -	No Clear
E. -	Earth	N.G. -	No Glow
E.A. -	Earth on A Line	N.P. -	Normal Post
E.B. -	Earth on B Line	N.R. -	No reply
Eng. -	Engaged	N.R.A. -	No rotary action
Ext. -	Extension	N.Rel. -	No release
Extl. -	External	N.V.A. -	No vertical action
F.A. -	Fire Alarm	O.C.B. -	Originating Calls Barred
Flex. -	Flexible	O/A- -	Out of Adjustment
Flty. -	Faulty	O/H -	Overhead
F.O.K. -	Found all right	O/J -	Outgoing junction
F.S. -	Finger Stop	O/L- -	Outlet
Ft. -	Faint	O.O.O. -	Out of Order
		O/N -	Off normal
Gen. -	Generator	Opr. -	Operator
Get W.N. -	Gets wrong numbers		
Gov. -	Governor	P.B. -	Primary Battery
		P.B.B. -	Permanent Busy Back
H.B. -	Hearing bad		

P.B.X.	-	Private Branch Exchange	Selr.	-	Selector
P.C.	-	Permanent Current	S.H.S.	-	Switch held by sub.
P.E.	-	Partial Earth	Sig.	-	Signal
P.Lp.	-	Permanent Loop	Spg.	-	Spring
Pos.	-	Position	S/L	-	Spare level
Pr.	-	Pair	S/No.	-	Spare Number
Protr.	-	Protector	Ser.	-	Service
P.U.	-	Plugged up	Spec.	-	Special
P.Wpr.	-	Private Wiper	Sub.	-	Subscriber
			Sw.	-	Switch
			Swhk.	-	Switchbook
R.	-	Ring Connection	T.	-	Tip
R.A.	-	Rotary Action	T.C.	-	Test Clerk
R.B.	-	Receiver Broken	T/C	-	Traffic Congestion
R.C.B.	-	Receiver Cap Broken	T.D.S.	-	Time delay switch
R.D.	-	Routine Duty (No.)	Tk.	-	Trunk
Rec.	-	Receiver	Tele.	-	Telephone
Recd.	-	Received	T.O.	-	Testing Operator
Reg.	-	Register	T.O.S.	-	Temporarily out of service
Rel.	-	Release	T.R.	-	Test Room
Reld.	-	Released	T.Rel.	-	Tone Relay
Rel.R.	-	Release Relay			
Res.	-	Resistance	U/G	-	Underground
R.Inter.	-	Rotary Interrupter	V.A.	-	Vertical Action
R.M.	-	Rotary Magnet	V.M.	-	Vertical Magnet
R.Sw.	-	Rotary Switch			
R.Spg.	-	Ratchet spring	W.N.	-	Wrong Number
R.W.T.	-	Right when tested	W.Rec.	-	Watch Receiver
R.L.Sw.	-	Rotary Line Switch	Wpr.	-	Wiper
R.V.	-	Ringling Vibrator			
S.	-	Sleeve	Xtr.	-	Transmitter
S.B.	-	Speaking Bad			
Sbd.	-	Switchboard			
S.C.	-	Short Circuit			

APPENDIX VIII.

List of Routine Tests and Inspections.

Test No.	Item.	Periodicity of Tests.	Remarks.
1	Local Call Regular - - - -	2 months -	See Para. No. 144.
2	Local Call. Called Line Busy - -		" " " 145.
3	Junction Call. Outlet Free - - -		{ Single Jctn. cases only. See Paras. Nos. 146-150.
4	Junction Call. Outlet Busy - - -		
5	Junction Call. Last outlet Free -		
6	Junction Call. All outlets Busy -		{ Multi-Jctn. cases only.
7	Forced step-on feature of assignment switch when a connecting link fuse is blown.		See Para. No. 151.
8	Step-on of Assignment Switch when a selector fails to restore.	3 months -	" " " 152.
9	Forced step-on feature of line finder		" " " 153.
10	Metering conditions on connecting links		" " " 154.
11	*Subs. Calling equipments and meters		" " " 155.
12	Time Delay Switch - - - -		" " " 156.
13	N.U. tone - - - -		" " " 157.
14	Fault Test circuit - - - -		" " " 158.
15	†Insulation of Subscribers' lines -		" " " 159.
16	Cleaning of bank contacts - - -		" " " 122.
17	†Dial Speed Tests - - - -		" " " 111.
18	Inspection of all exchange equipment	Yearly -	

* The routine test of the subscriber's meters should be so arranged as to be completed before the last two weeks of each quarter. This will avoid the necessity for last-minute amendments being made to subscriber's accounts by the District Manager's Staff

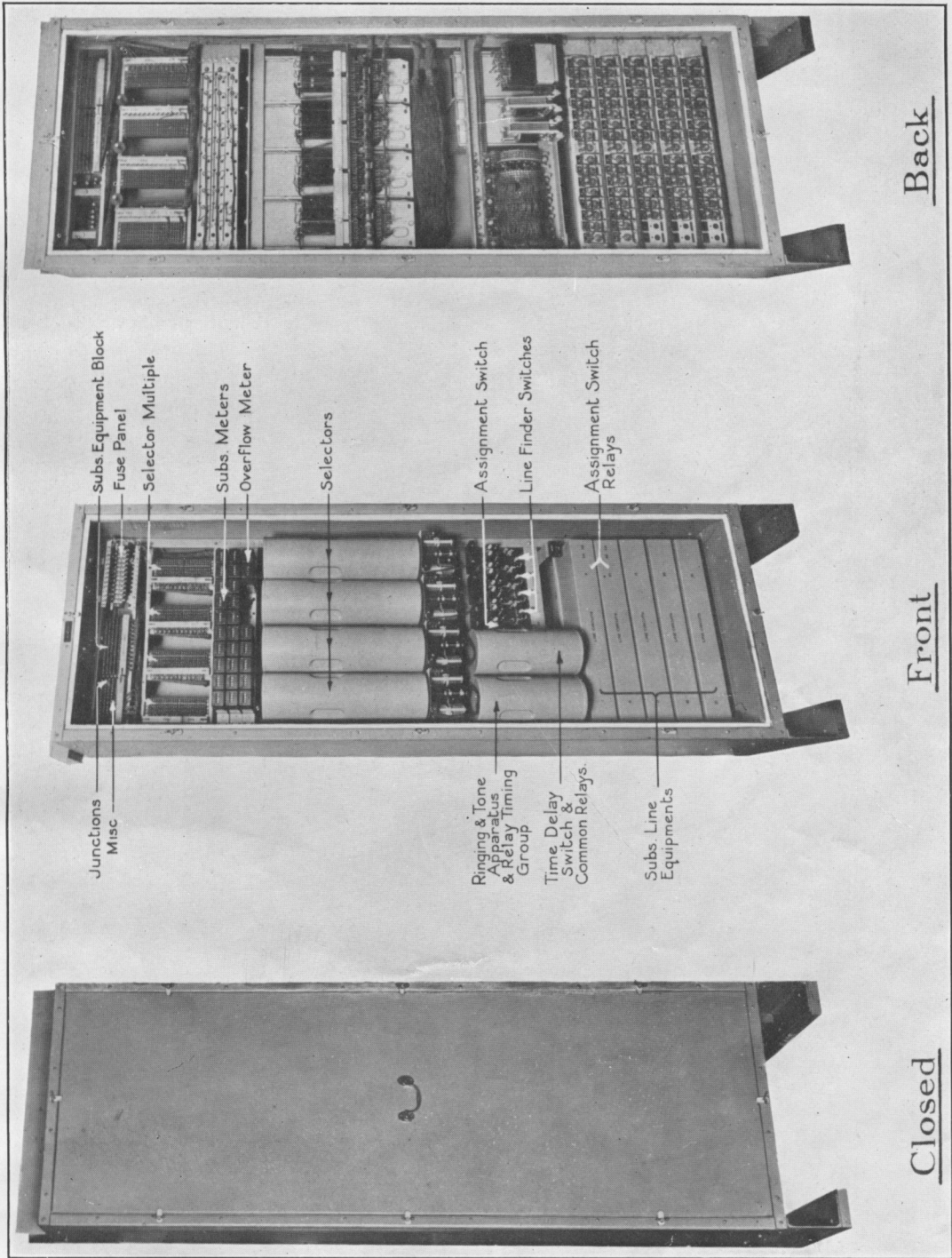
† It will be convenient to combine these two tests.

INDEX.

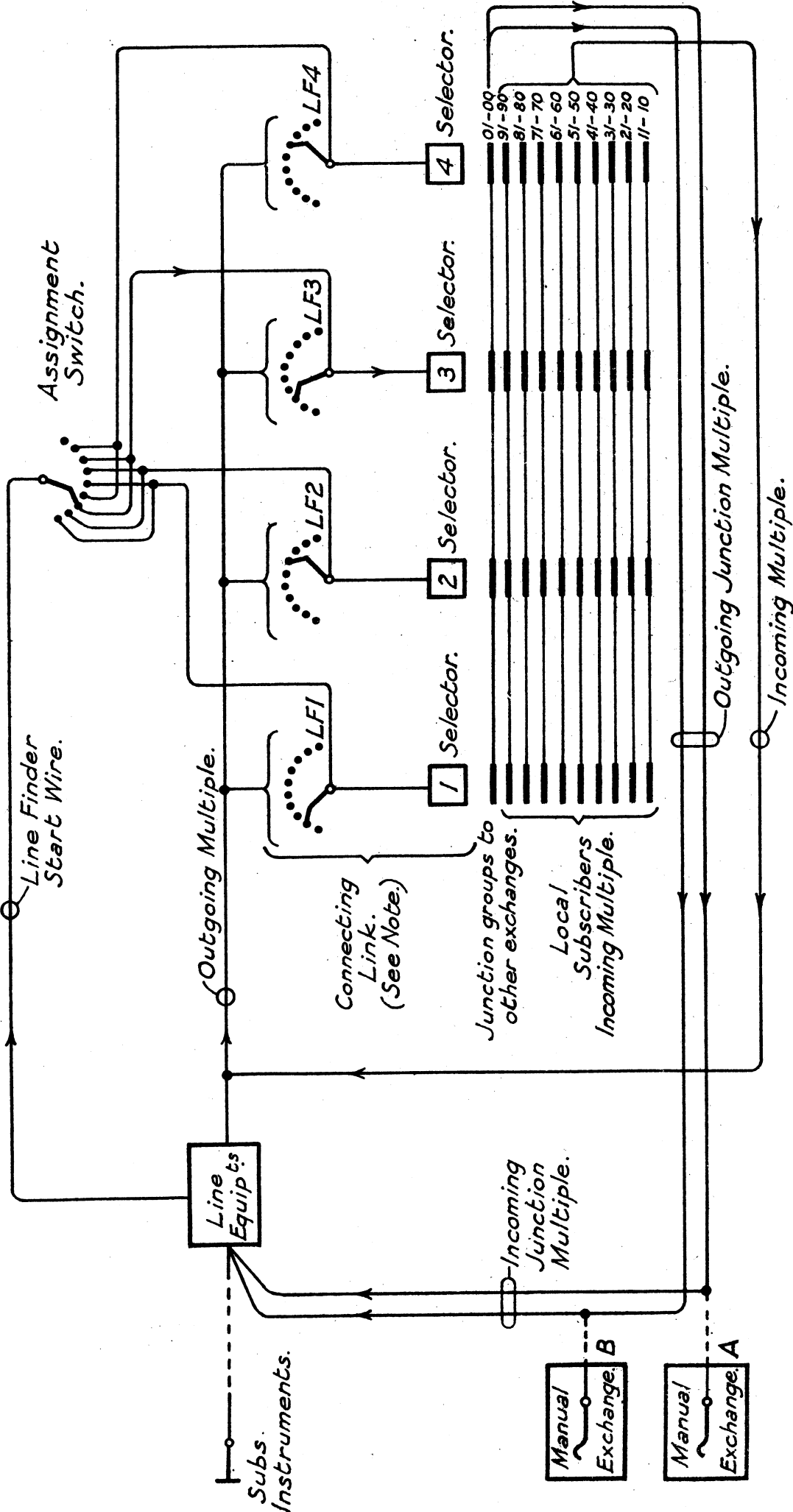
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25-line Rural Automatic Exchange Unit (Unit Auto. No. 5).



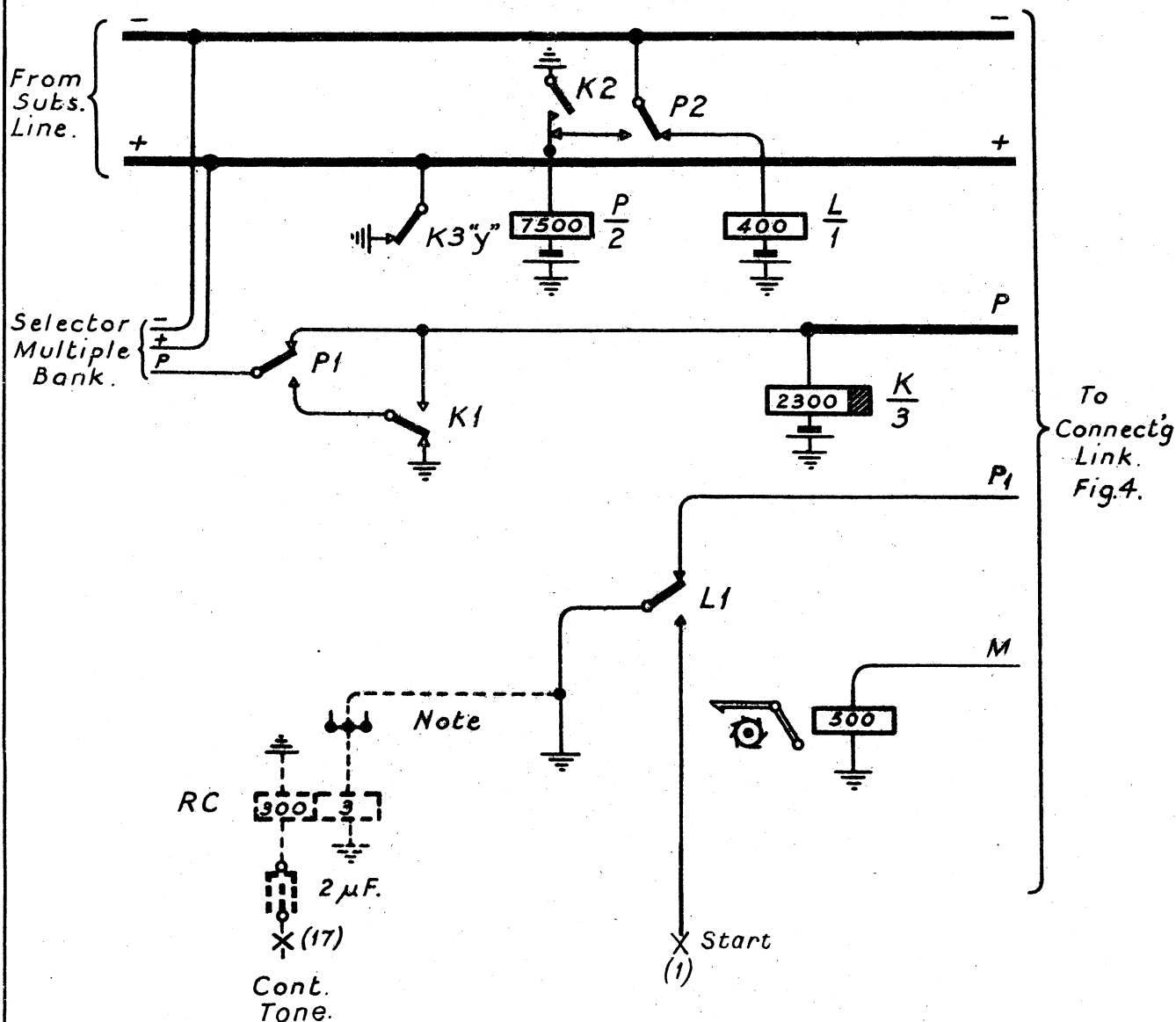
(C)

Note :- A connecting link consists of a line finder and its associated selector.

UNIT AUTO. N° 5.

RURAL AUTOMATIC EXCHANGE.

ELEMENTARY CONNECTIONS OF A 25 LINE UNIT.



Note.

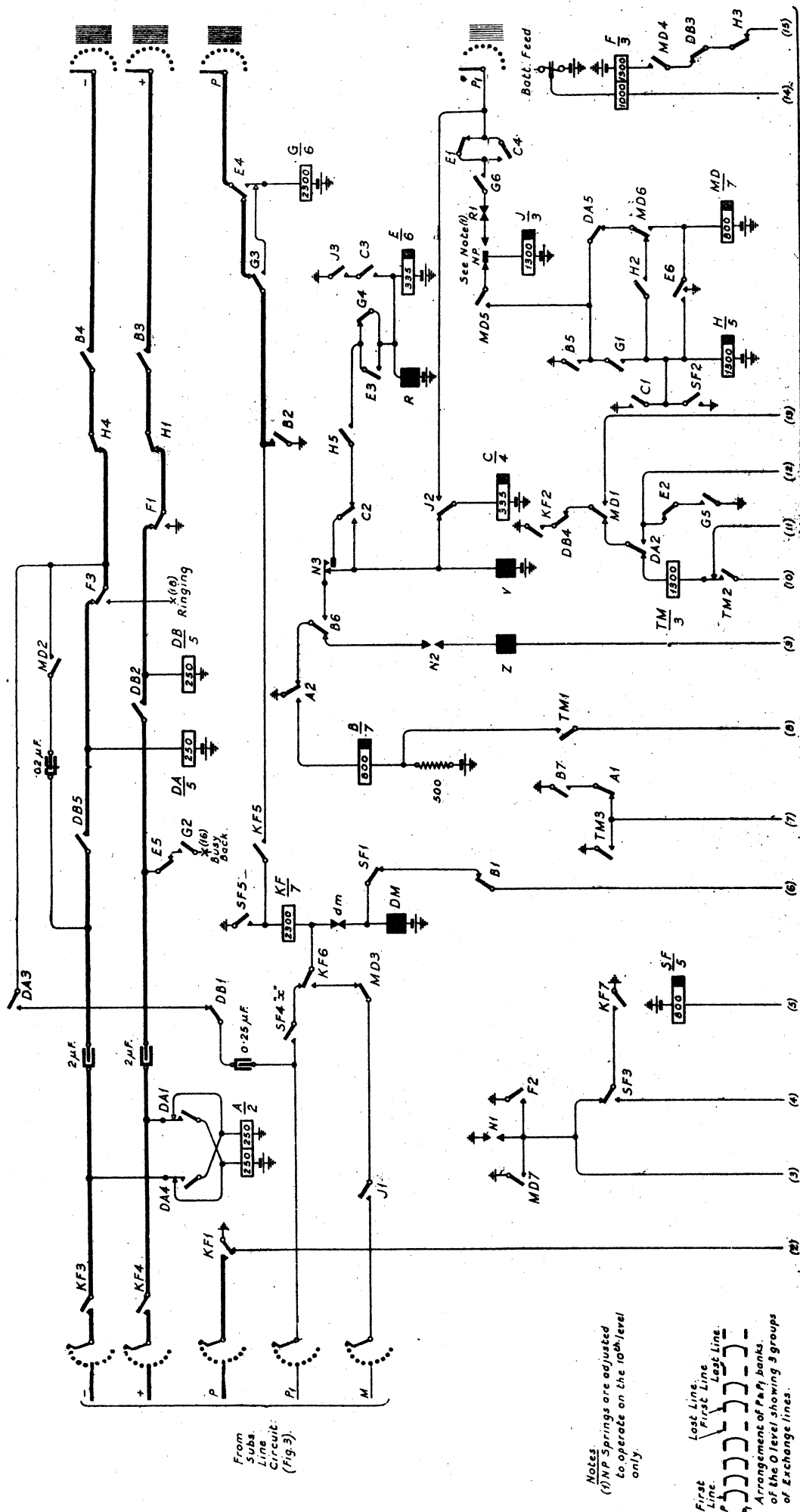
When a coin box line is connected to this circuit the Earth is disconnected & the dotted connections are inserted.

For particulars of (1) and (17) see Fig. 5.

RURAL AUTOMATIC EXCHANGE.

(25/100 LINE. 2 DIGIT SYSTEM).

SUBSCRIBERS LINE CIRCUIT.



To Assignment Switch Common Apparatus.
(Fig. 5).

For particulars of (1) to (10) see Fig. 5.

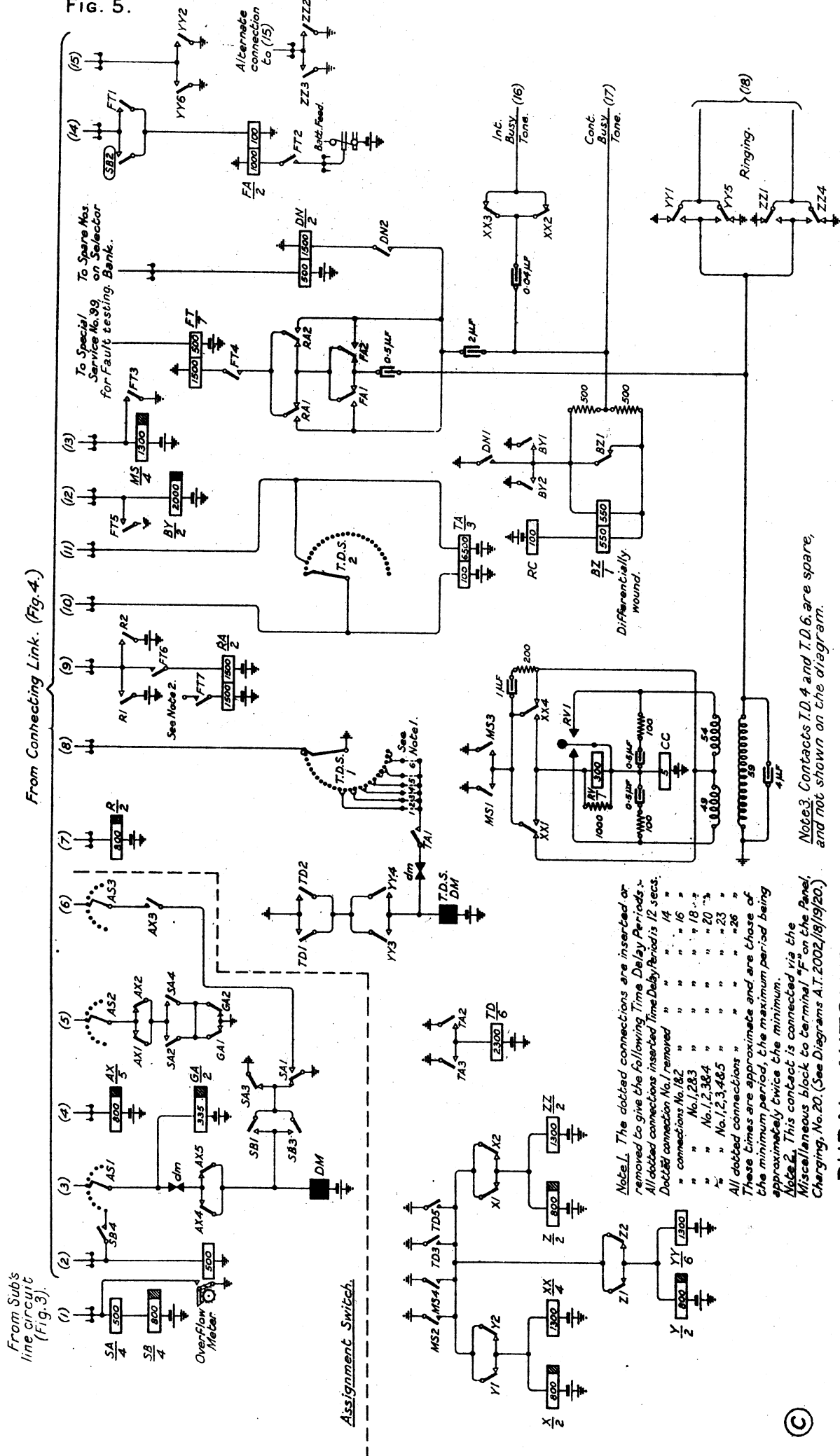
RURAL AUTOMATIC EXCHANGE. (25/100 LINE. 2 DIGIT SYSTEM)

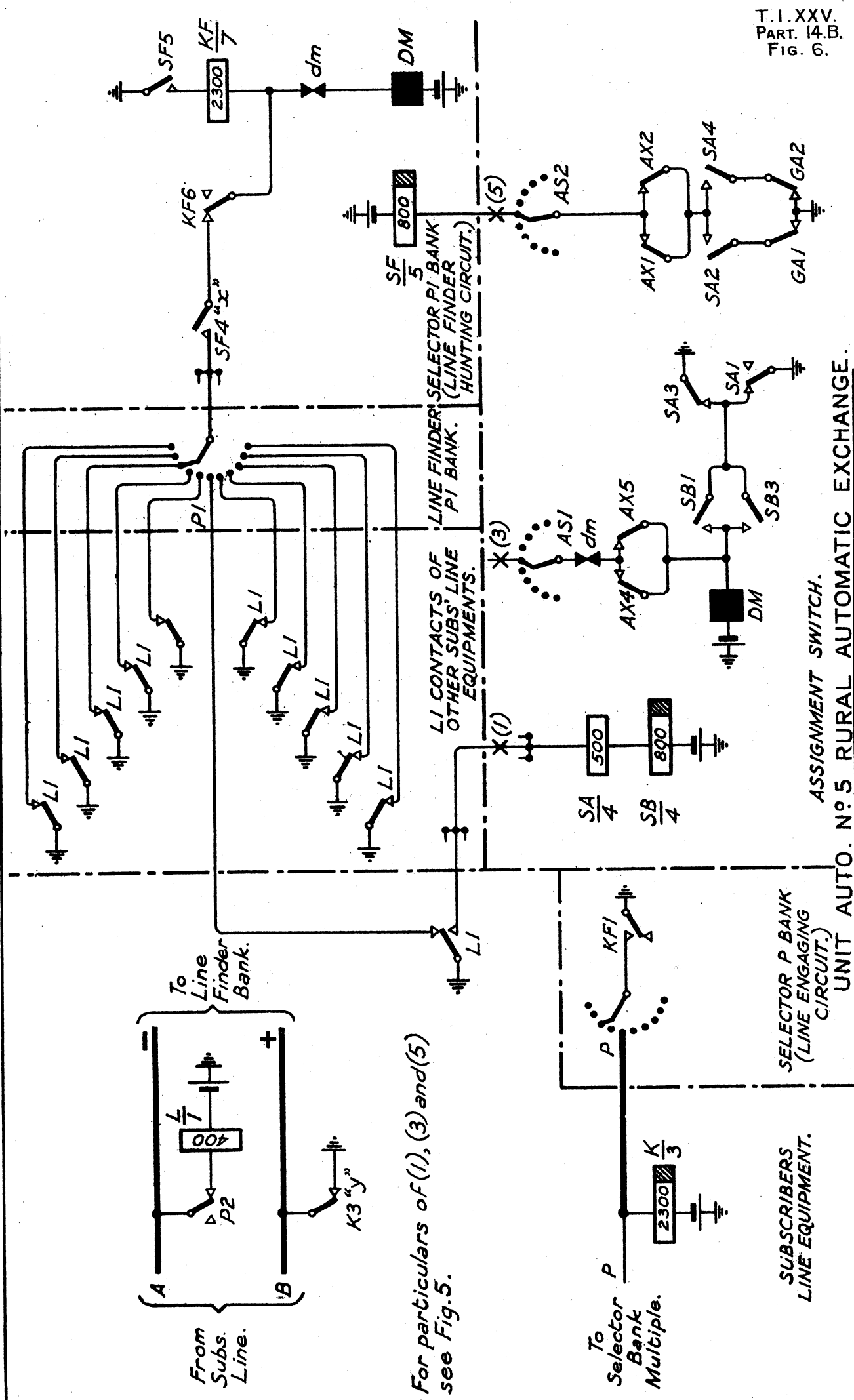
CONNECTING LINK LINE FINDER AND SELECTOR.

Notes:
(1) NP Springs are adjusted to operate on the 10th level only.

[illegible]

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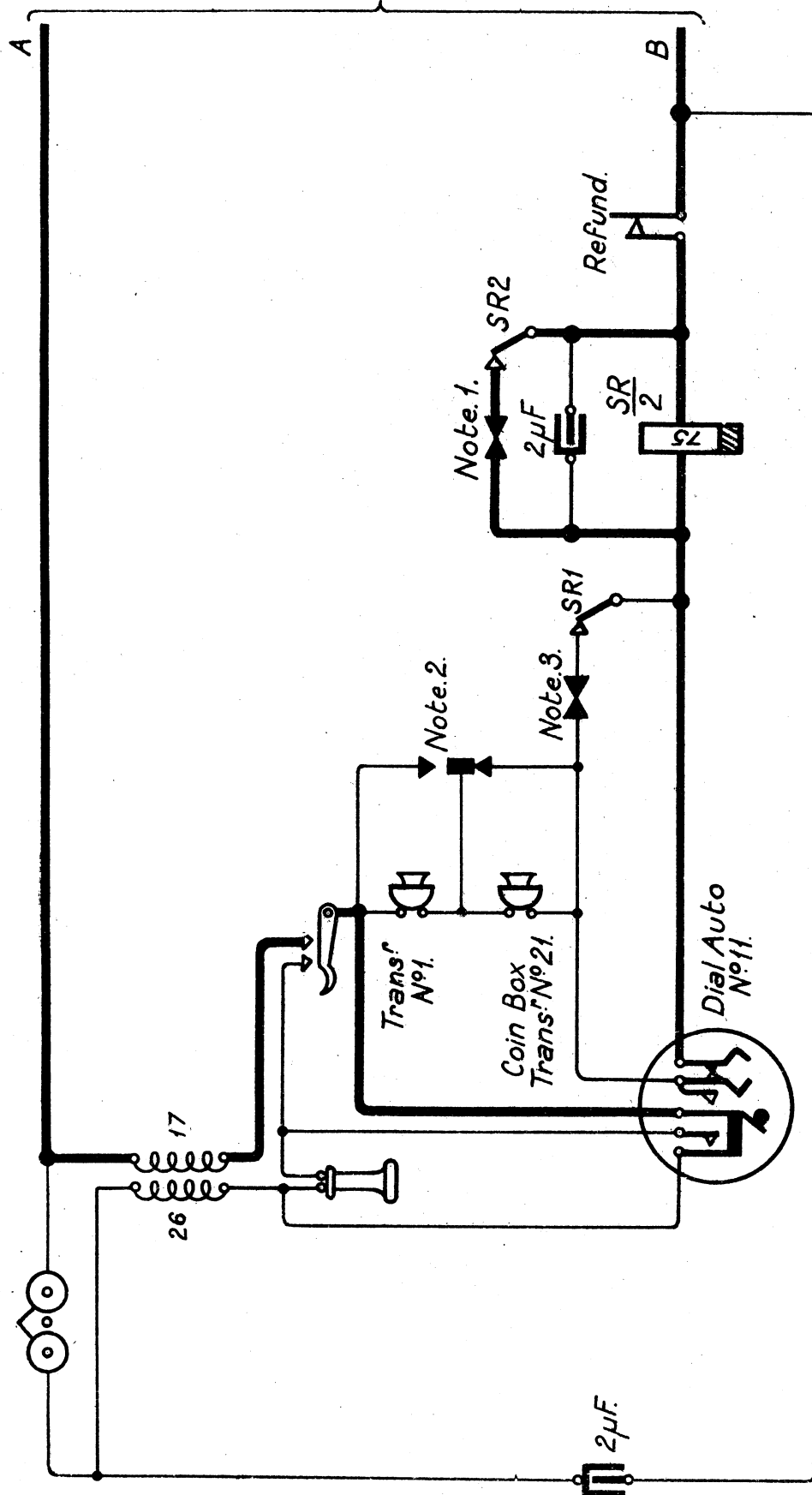




For particulars of (1), (3) and (5) see Fig. 5.

UNIT AUTO. N° 5 RURAL AUTOMATIC EXCHANGE.

LINE FINDER, ASSIGNMENT AND HUNTING CIRCUITS.

[illegible]

TELEPHONE No 123.

MODIFIED FOR USE IN CONNECTION WITH
UNIT AUTO N° 5.