

**THE INSTITUTION OF
POST OFFICE ELECTRICAL ENGINEERS**

**Rural
Automatic Exchanges.**

25/100 Line (Unit Auto No. 5.) System.

BY

J. C. DALLOW.

A PAPER

*Read before the London Centre of the Institution
on December 10th, 1929.*

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Introduction.

An endeavour will be made to describe the principal features of the 100 line Rural Automatic Exchange scheme which has been adopted by the British Post Office.

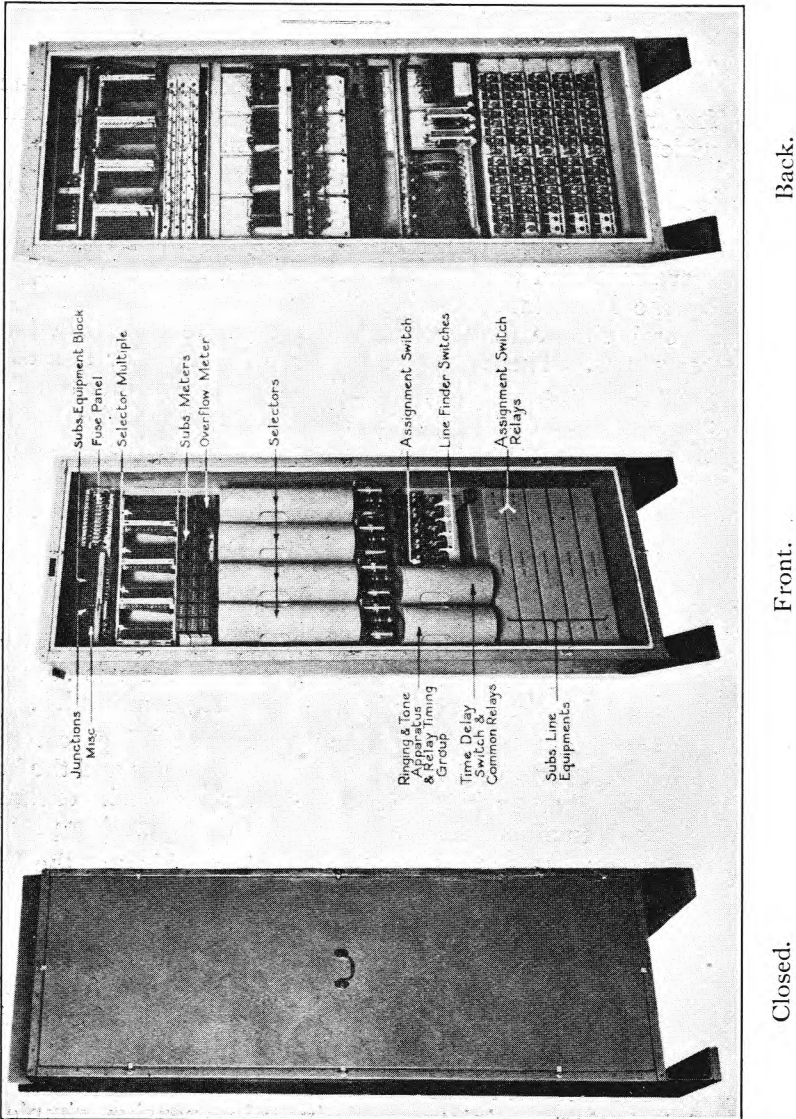
Reasons for re-consideration of Rural Exchanges.

The question of the provision of automatic exchanges to serve scattered country subscribers had not been overlooked by the Department during the progress of automatics, and several village automatic exchanges were established some years ago. These were, however, of a more or less experimental nature, and it became necessary to consider the matter on more general lines for the following reasons, the first three of which are of particular interest to prospective subscribers.

- (a) The great convenience of the continuous day and night service given by the automatic system.
- (b) The rapid connections obtained as contrasted with the indifferent operating which sometimes occurs at rural manual exchanges.
- (c) The increased satisfaction given to subscribers by the knowledge that the automatic system is secret, an important point in a small rural community.
- (d) The increasing difficulty in obtaining caretaker-operators for rural manual exchanges and the heavy charges involved in transferring such exchanges to other premises because of the operating problem.
- (e) The introduction of automatic working at the larger exchanges, thus making it desirable to introduce automatics at small exchanges.
- (f) The great improvement in the design of automatic plant and the elimination of circuit defects, which make it possible to leave the apparatus for considerable periods without attention.

The problem was therefore approached with the view of designing a miniature, relatively inexpensive, simple and self contained automatic exchange which could be made by

mass production methods and housed in a small building erected to a standard plan. The type of equipment decided upon was the unit illustrated in Fig. 1.



THE AUTOMATIC EQUIPMENT.

FIG. 1.

New Automatic Unit—Facilities Provided.

This apparatus—known as the Unit Auto No. 5—has the following features:—

- (a) The unit is a cabinet, 6 ft. 3 ins. high × 2 ft. wide × 1 ft. 3 ins. deep, and is fitted with front and rear doors closing on to felt. The cabinet itself and the doors are constructed with double air spaced sheet iron in order to retard the rate of temperature change inside the unit.
- (b) The unit contains all the equipment necessary for the working of the exchange, with the exception of the power plant. One unit has capacity for a combined total of 25 subscribers and junction lines, and a maximum of four units can be installed in one exchange.
- (c) The equipment is designed to function from secondary cells within a voltage range of 46 to 52, a dial range of 7 to 14 impulses per second, a maximum line loop resistance of 1200 ohms, and a minimum insulation value of 20,000 ohms. The last factor has been made as low as practicable in view of the difficulty which usually obtains in maintaining good insulation on overhead plant in rural areas. Standard automatic telephones with central battery transmission are fitted at subscribers' premises.
- (d) Junctions—to a maximum of ten—may be provided to one or more distant exchanges. Considerable simplification of the rural auto apparatus and great flexibility have been obtained by connecting the incoming sides of the junctions exactly as ordinary subscribers. The distant exchange end of a junction terminates on the manual board in a circuit which can be easily adapted to work with any kind of manual equipment including an auto-manual board. No cord circuit alterations are necessary.
- (e) " Busy," " Ringing," and " N.U." tones are provided.
- (f) Automatic metering on local calls. Junction calls are not metered but are recorded by the distant exchange operator.
- (g) Coin box working, using the Hall multi-coin box, is catered for, local calls from a coin box circuit

being completed automatically, while the operator at the distant manual exchange, on the operation of a key, receives a distinctive tone when answering a junction call originated by a coin box caller.

- (h) The supervisory signal on junction calls, in either direction, is controlled by the rural auto subscriber's switchhook.
- (j) Forced release is applied in 12 to 25 seconds to a selector held by a subscriber who has failed to dial or who has dialled one digit only. It is also brought into operation under "called subscriber held" and faulty line conditions. The period which must elapse before the release is applied may be varied between a minimum of 12 to 25 seconds and a maximum of 30 to 60 seconds.
- (k) In order to avoid waste of battery power in cases of permanent loop or equivalent conditions, the equipment is so arranged that after an interval of 12 to 25 seconds the forced release is applied. This results in the common apparatus and the subscriber's calling equipment being released, whilst the line is busied and held on a high resistance relay. If the subscriber replaces the receiver, or if, in case of line trouble, the fault disappears, the circuit is restored to normal working.
- (l) No alarms are provided, but the operator at the distant manual exchange can, by dialling "99," ascertain certain conditions at the rural auto exchange.

If inverted ringing tone is heard conditions are O.K., but if N.U. tone is received the indication is that certain faulty conditions exist.

If neither ringing signal nor N.U. tone is received the indication is that the ringing has failed or the junction is out of order.

New Automatic Unit—Facilities not provided.

Certain facilities, not considered to be essential, have not been catered for. These are:—

- (a) Dialling tone. The provision of this tone would entail circuit complication; an overflow meter is,

however, provided to register calls which might be lost due to all outlets being engaged.

- (b) Party-line working. Party lines are open to several objections, the more important being :—

Non-secrecy.

Greater fault liability per subscriber (*i.e.*, when one branch of a party-line is faulty all the subscribers are generally out of service).

Complication of apparatus.

Ringing and metering difficulties.

A further consideration which tends to reduce the demand for party lines is the extension of the free radius from $1\frac{1}{2}$ to 2 miles.

- (c) Trunk barred facilities. Junction and Trunk calls form 80 to 95 per cent. of the traffic originated by rural subscribers, and trunk barred facilities would therefore receive a very limited support, and would be difficult, if not impossible, to provide.

- (d) Trunk offering and operator hold. The reason for excluding these facilities requires a little explanation.

The manual exchange which deals with indirect junction traffic for the rural auto exchange is known as the " Parent Exchange " and it is arranged that all the junctions from a rural auto exchange to the parent exchange terminate on one position and are not multiplied. Consequently one operator supervises all the trunk calls to and from a rural auto exchange. For this reason, and also in view of the high percentage of junction traffic it is very probable that an engaged subscriber who is wanted for a trunk call will be directly accessible to the operator by breaking in on a connection already established on the cord circuits.

- (e) Through dialling facilities. The provision of through dialling would allow junctions from a rural auto exchange to terminate on automatic switches at distant exchanges, so that two rural auto exchanges could work together, and also, a rural auto exchange could form part of an automatic network. Owing, however, to the non-standard

nature of the rural auto tones and the absence of dialling tone such facilities would cause great confusion. Further, rural auto exchanges are like milestones in that, although numerous, they are exclusive and lonely, and it is probable that the facility would be little used. Again, considerable circuit difficulties and expense would arise in providing the facility on outgoing calls.

Trunking Scheme.

We now come to the consideration of the trunking scheme of the rural auto exchange (Fig. 2).

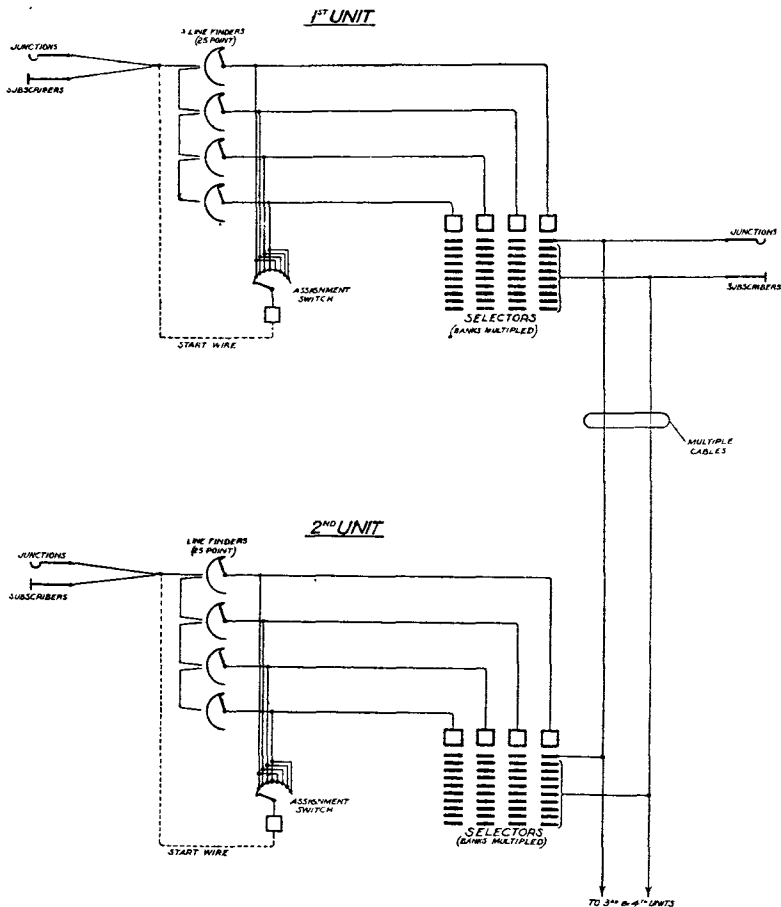
All calls, whether junction or local, are effected by the dialling of two digits, the connections for both subscribers and junction calls being made by means of "Connecting Links," four of which are fitted in each unit. Each connecting link consists of a line finder (a non-homing rotary line switch) associated with a two-motion selector of the Strowger type.

An "Assignment Switch" allocates the connecting links in consecutive order as calls are originated. Normally the wipers of this switch are standing on the contacts of a disengaged connecting link, and this link is seized by the next call. The assignment switch is then stepped to the next free link.

The subscribers and junction lines are multiplied 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 is brought into operation *via* the assignment switch and its wipers are rotated until they reach the bank contacts associated with the calling line, on which they stop. The selector of the connecting link is thus connected *via* the line finder to the calling line and receives two trains of impulses from the caller's dial. The selector wipers are stepped to the number dialled, ringing is automatically applied, and cut off when the called party answers. Metering takes place on local calls when the called subscriber lifts the receiver. All apparatus returns to normal when the caller replaces the receiver.

Numbering Scheme.

The numbering scheme is arranged so that levels 1 to 9



TRUNKING DIAGRAM.

FIG. 2.

of the selectors can be used for subscribers' lines. When an exchange consisting of one unit is opened, the subscribers' numbers commence on level 2 and continue as more units are added, to level 9. The first level is brought into service last because the circuits on it are more liable to false calls caused by intermittent line faults.

Level "O" is reserved for junctions. 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. Two or more groups are, however, provided only in exceptional cases. When the second digit of a junction number has been dialled an automatic hunting circuit is brought into use on the "O" level, causing the selector wipers to step on if the first junction to the required exchange is engaged. This hunting continues as long as the selector wipers encounter busy junctions until the last line to the required exchange is reached. If this be engaged, busy tone is returned to the caller. The group of junctions to the parent exchange commences with the number "01" in all cases.

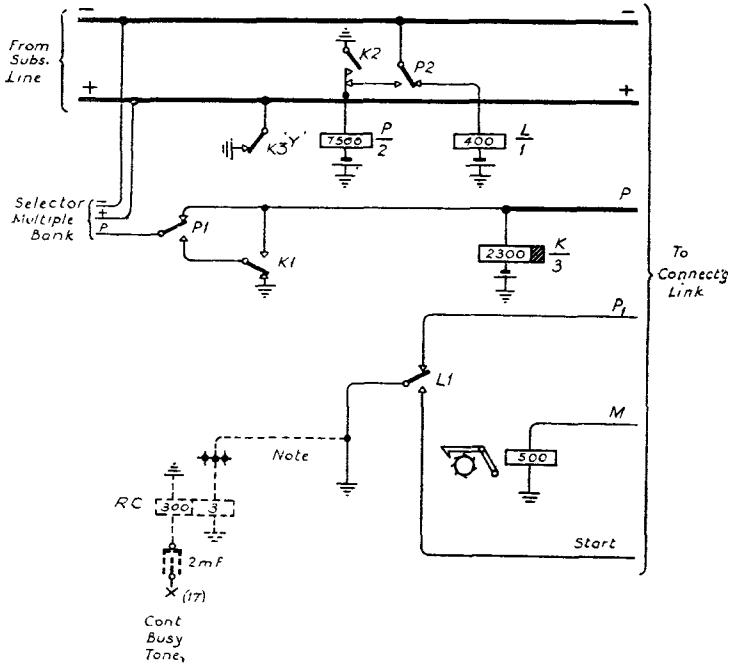
Circuits—Considerations in Design.

We are now in a position to consider the actual circuits. One of the chief considerations in their design was the minimisation of current consumption, and it will be seen there are several departures from accepted practices with this end in view. As instances, relays H and F of the selector (Fig. 4) are released during conversation, the transmission feed relays are $250 + 250$ ohms instead of the usual $200 + 200$, and a novel selector release circuit is provided.

Another consideration was the reduction of the fault liability as much as practicable, and, to attain this, more than the usual number of contacts are of platinum, and, in addition, most of those in the common equipment are duplicated. It is not intended to give a detailed description of the circuit, but merely to indicate the main functions, with special attention to unusual features.

Local Call.

Fig. 3 shows the calling apparatus associated with each line, whether subscriber or junction. The usual calling relay "L," the cut-off relay "K," and a high resistance relay "P" which isolates faulty lines from the connecting links, are provided. The wires shown to the right terminate on the arcs of the line finders of the connecting links together with similar connections from the other 24 calling circuits. Normally earth is extended to the connecting links *via* L₁, but when the subscriber calls, this earth is changed over to the common start wire to the assignment switch. The line finder magnet of a connecting link is operated *via* the assign-



NOTE.—When a coin box line is connected to this circuit the earth is disconnected and the dotted connections are inserted.

× For particulars of (17) see Fig. 4.

SUBSCRIBER'S LINE CIRCUIT.

FIG. 3.

ment switch and hunts round the bank until it comes to this disconnected contact on which it stops. K is operated *via* the private, K2 operating P.

The subscriber now dials the two digits and the call proceeds. On completion of the call, when the caller hangs up, the earth holding K is removed by the connecting link. Now, when the make-before-break contacts, K2 release, P is momentarily extended to the line. Normally it releases, but if the insulation resistance is less than about 12,000 ohms, the relay will lock, thus preventing the operation of L and isolating the circuit.

It will be seen that any condition which causes the release of K will cause P to be extended to the line whether K is operated on an outgoing call *via* the line finder, or on an incoming call *via* the selector bank. This feature will be dealt with later in connection with the Time Delay Switch circuit (page 15). Another point is that on coin box lines continuous tone is connected to the P1 bank contact of the line finder.

We now turn to the connecting link and common apparatus (Fig. 4). There is no unusual feature in the normal operation of the line finder. Its start relay, SF, is operated by the assignment switch, and when the calling subscriber's circuit is found KF operates and extends earth to the assignment switch. KF also extends the calling subscriber to relay A of the link and starts the time delay switch. The operation of the vertical and rotary magnets on subscribers' levels calls for no special comment. When the second digit is dialled the earth operating the time delay switch is changed over to operate the ringing vibrator, and when the wipers have rotated to the required line G tests the private. If the line is free, ringing is applied *via* F1 and F3. Relay F is operating intermittently while ringing is applied and in its released periods connects the back bridge relays DA and DB to the subscriber's line. These two relays operate in series during the next silent period after the called subscriber removes the receiver. F releases, and the two subscribers are in conversation. Relay MD is also released when the called subscriber answers and in turn disconnects the ringing apparatus and the metering relay J. Relay J is slow and during its release period a circuit is provided for the calling subscriber's meter, thus registering the call.

On completion of the conversation, assuming that the calling subscriber hangs up first, A releases. While B retains, a circuit is completed for a common release relay R. This relay is also slow, and it retains when B drops back and completes the circuit of Z, long enough to release the selector.

Spare Numbers.

All spare numbers have their positive multiple bank contacts connected to relay DN, which operates when a spare number is dialled. Continuous tone is then generated and passes through one winding of relay DN, which functions as an induction coil and tone is transmitted to the caller.

Junction Call.

On the " O " level only, a P₁ bank is wired, and the P and P₁ contacts are strapped on all the junctions of a group except the last, the P₁ contact of the last junction being disconnected.

The first digit will be " O," and when the switch shaft reaches the " O " level, relay J, previously the metering relay, is changed over by the normal post springs to become the rotary search relay.

The subscriber dials the second digit, say 1, which moves the wipers to the first bank contact. If this is busy G operates and brings in the hunting circuit on the P₁ contact. Relays J and C operate and the wipers are stepped to the next contact. Relay G tests again and if the junction is busy the wipers are stepped until a free line or the last line of the group is reached. Owing to the P₁ contact of the last line being disconnected, J cannot re-operate, and G locks and returns busy tone to the caller. If a free line is found the equipment operates in precisely the same manner as for a local call, ringing being transmitted to the distant exchange manual board.

Fig. 5 shows the junction equipment at the manual end. In the majority of cases the apparatus is supplied as a complete unit, various points in the circuit being brought out to connecting tags in order that the connections may be altered to suit the cord circuit conditions at any type of exchange.

Taking the case for a C.B.S. No. 2 exchange; the ringing from the rural auto exchange chatters relay L, operating and locking LL, thus completing the circuit of the calling lamp or indicator. On plugging in, S is operated *via* one winding and the ringing is tripped by the short-circuit provided by LL contacts. To ensure that the operator makes the coin box test it is arranged that LL holds the short circuit across the line until the operation of the coin box key removes it. This key applies earth through a 400 ohm inductive circuit to the negative line and earth through 3000 ohms non-inductive to the positive line. Under these conditions, tone is now heard if the call is originated by a coin box caller. The connection is completed by the operator. The clearing signal on calls incoming to the manual exchange is controlled by the rural auto subscriber by means of relay LA, which is connected across the junction.

On outgoing calls the operator dials the rural auto

number required, and supervision in this case also is governed by the rural auto subscriber. The shunt field relay D in the junction circuit operates or releases according to the direction of current in the junction, the latter being under the control of the called subscriber in a manner similar to the standard final selector arrangement.

Connecting Link Auxiliary Circuits.

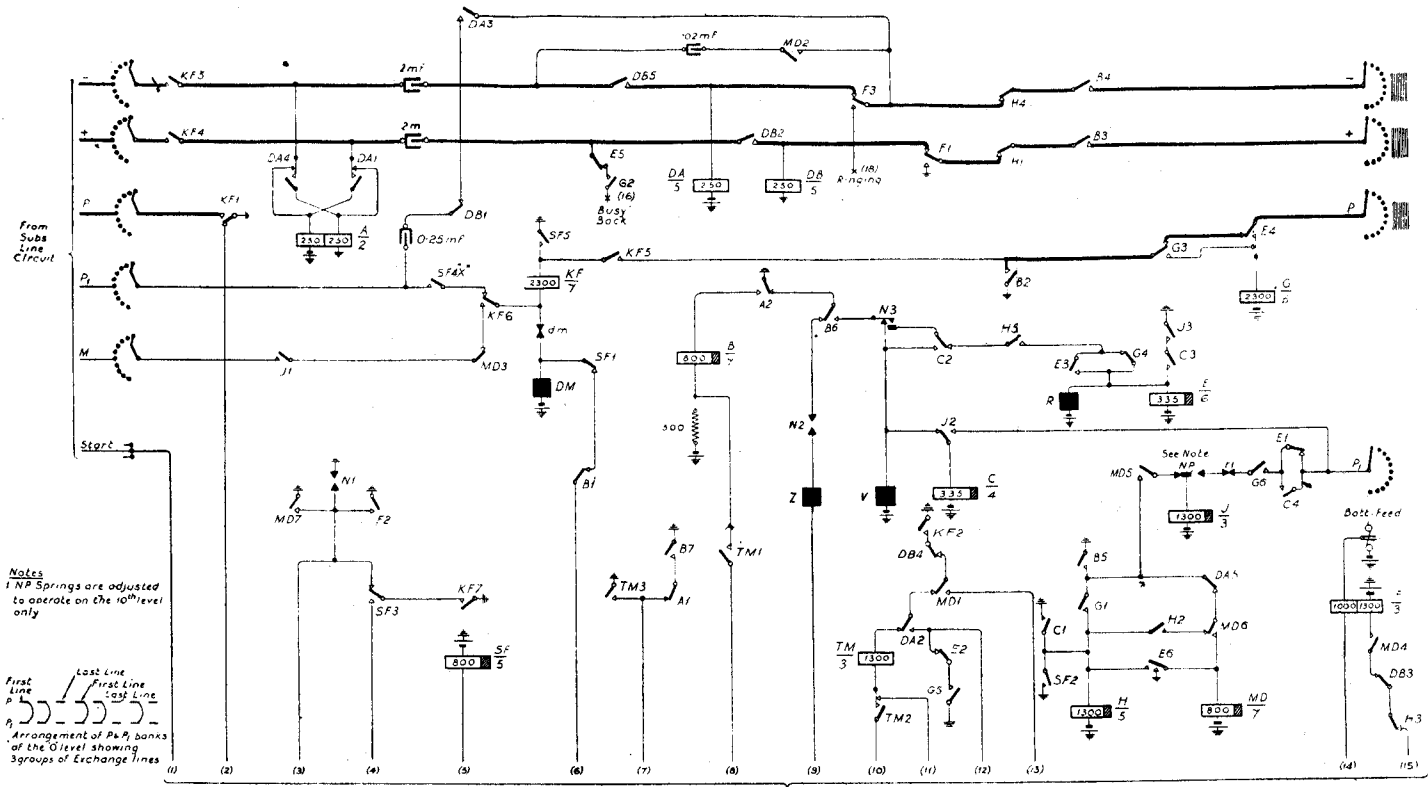
Let us now return to the rural equipment and discuss the various auxiliary circuits (Fig. 4). There are two such circuits in the connecting link which require explanation.

- (a) *Coin Box Tone.* By means of the key at the distant manual board the operator can apply earth to the junction when answering a call from the rural auto exchange as explained above. It will be seen that this holds relay DA and short circuits DB. By this means continuous tone is transmitted from the subscriber's equipment *via* the line finder to the negative line and to the operator, thus indicating that a coin box line is calling.
- (b) *Forced Step on Line Finder.* Should a fault develop in a subscriber's equipment so that the line finder P₁ contact is permanently disconnected, it will be seen that the whole unit would soon be put out of service, as all four line finders would revolve to the faulty line and stay there. This is avoided by providing a circuit *via* B₁ which gives one step to the line finder magnet if a connecting link is seized but the B relay is not operated. Neither A nor B relay will be operated if the line finder stops on a faulty contact because that subscriber is not calling, so the finder is stepped over it and continues hunting for the calling subscriber.

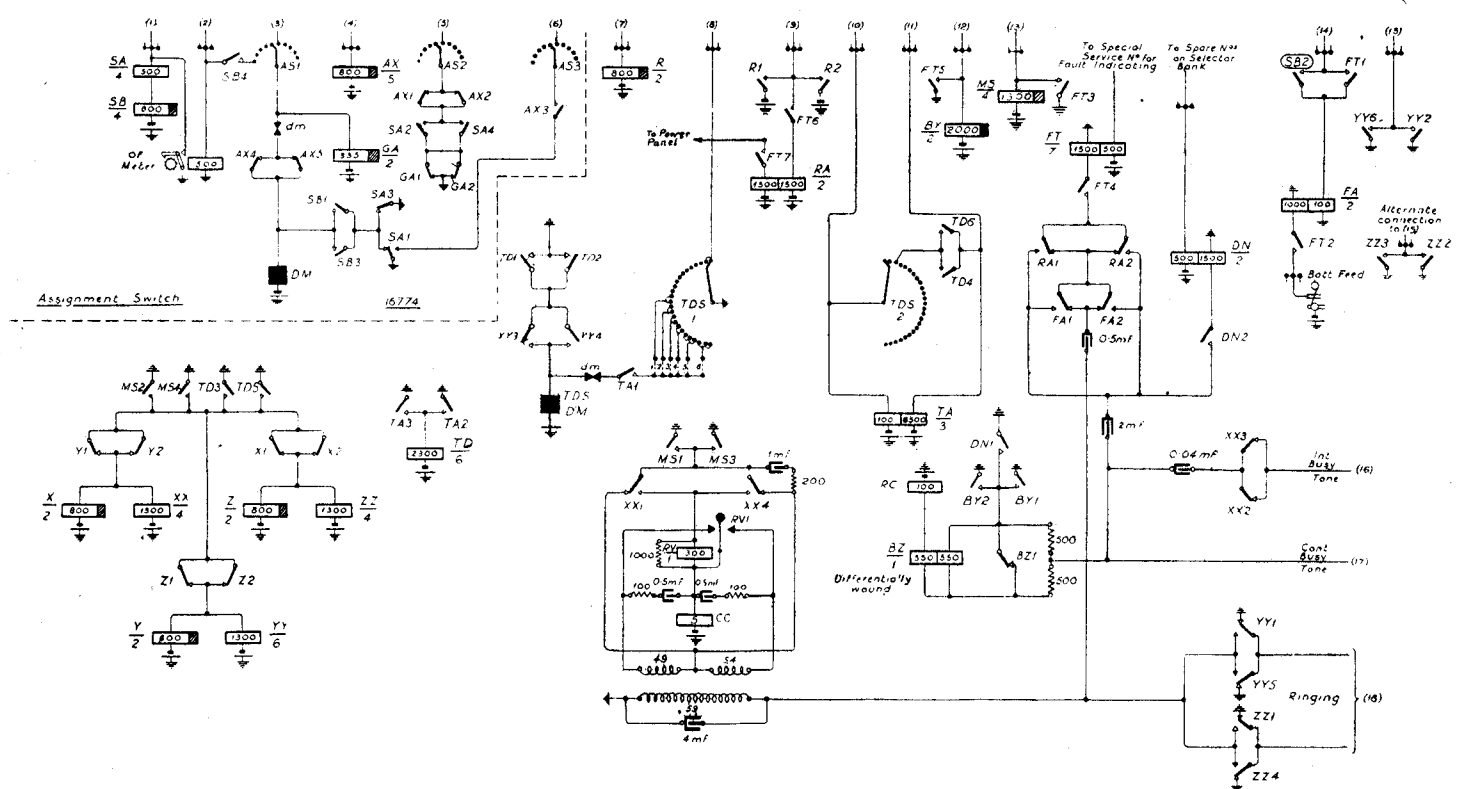
Common Apparatus.

This equipment consists of:—

- (a) Assignment switch. (One is fitted in each unit).
- (b) Relay Timing Group.
- (c) Time Delay Switch.
- (d) Ringing Vibrator.
- (e) Tone Apparatus.
- (f) Fault Test Group.



To Assignment Switch & Common Apparatus



CONNECTING LINK, ASSIGNMENT SWITCH, AND COMMON APPARATUS.

FIG. 4.

The equipment (b) to (f) is common to the exchange.

The assignment switch has wires from the four connecting links multiplied six times round its banks, and the first contact is used for the overflow meter. When a call is made relays SA and SB operate. SA closes the circuit of the start relay of the connecting link upon which the assignment switch wipers are standing. When the calling line is found by the line finder SA and SB are disconnected. SB is slow and during its release period a circuit is provided for the assignment switch magnet, and the wipers are stepped to the next free link.

If all links are engaged the wipers stand on the first contact and if another subscriber now calls, the overflow meter operates once and holds SA and SB. When a connecting link is freed earth is extended to short-circuit the meter, and the assignment switch magnet operates and rotates the wipers to the free link.

The relay timing group consists of a group of six relays which control the time delay switch, ringing vibrator and busy tone. Three of the relays, X, Y and Z are slow-releasing, and it will be noticed that the circuit of each is completed *via* break contacts of one of the other two. At first sight it would appear that when earth is applied simultaneously as shown, the relays would merely chatter in unison, and this would be the result if the mechanical and electrical characteristics of each relay were absolutely identical. What actually occurs is that one of the three breaks its contacts first, and the three relays immediately fall into operation and release in a cyclic order, the first re-operating when the third releases. The auxiliary relays XX, YY and ZZ are each operated in turn for one third of a second, and these relays control other circuits in the common apparatus.

The time delay switch provides forced release to selectors held by abnormal conditions. At the stage when relay KF in a connecting link operates, earth is extended *via* TM to operate TA *via* its high resistance winding. TA operates, TM remaining normal. The relay timing group is energised and the wipers of the time delay switch are stepped at the rate of once per second by YY contacts. On reaching the third contact the low resistance winding of TA is connected and relay TM now operates. The switch continues stepping slowly until it reaches the twelfth bank contact, when a self-stepping circuit is completed *via* interrupter springs and the

wipers move rapidly over the remaining bank contacts. When the wipers step to the first contact again earth is extended *via* the switch wiper to short-circuit relay B of the connecting link. The selector releases and removes the holding earth of the subscribers K relay. K, in releasing, allows the P relay to lock over the subscriber's line and as previously explained isolates it until the receiver has been replaced.

The time delay switch is started on every call, but, provided the two digits are dialled within 15 seconds, it is cut out before the release is applied. At the termination of a call it is also brought into use if the calling subscriber fails to replace the receiver.

The Ringing vibrator is started when MD operates on receipt of the second digit. It consists of a coil which is energised periodically by contacts of relay XX. When XX is operated the bob of the vibrator is attracted and held; on the release of XX the bob vibrates mechanically between the contacts on either side of it, completes in turn the circuits of the transformer coils and generates an alternating current of 16 periods per second in the third coil. Before the oscillations of the bob die down, the vibrator circuit is again completed. The ringing current generated is in the ratio of $\frac{2}{3}$ second ringing, $\frac{1}{3}$ second silence, but it is divided by contacts of relays YY and ZZ so that the ringing supplied to the selectors is $\frac{1}{3}$ second ringing, $\frac{2}{3}$ second silence. A noteworthy point is that the operation of the vibrator bob is not dependent on its own contacts.

Fig. 6 shows photographs of the vibrator. It will be seen that the only moving part is the bob, mounted at the end of a short length of clock spring, which is provided with platinum contacts. The actual length of the vibrator is $4\frac{1}{2}$ inches.

Continuous tone is generated by relay BZ. (See Fig. 4). When the circuit is closed by BY or DN contacts the relay operates and removes the short circuit from its second winding. This causes the relay to release, thus replacing the short circuit. These operations occur rapidly and a tone of approximately standard pitch is generated. Busy tone is provided by interrupting the continuous tone by XX contacts. Interruptions of $\frac{2}{3}$ second tone, $\frac{1}{3}$ second silence, are given. Fig. 7 shows photographs of the relay. The armature takes the form of a thin reed, the polepiece is slotted

FIG. 1 JUNCTION CIRCUIT

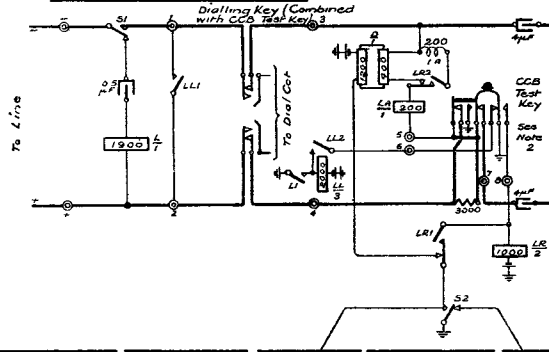
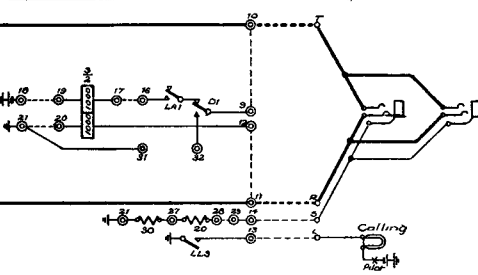
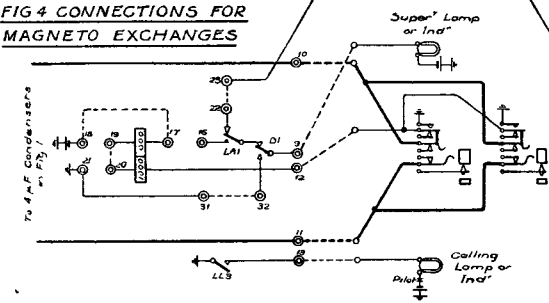


FIG. 2 CONNECTIONS FOR C.B. & C.B.S. No 2 EXCHS



Note
In 22 v. C.B. Exchanges 3 strap tags 27 & 28 in addition to those shown
In C.B.S. No.2 Exchs the existing 1500 ohm spool will be used instead of Tag #

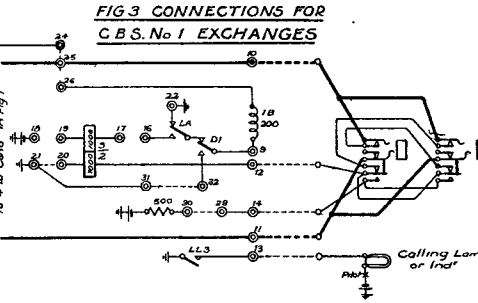
FIG. 4 CONNECTIONS FOR MAGNETO EXCHANGES



Transfer Circuits

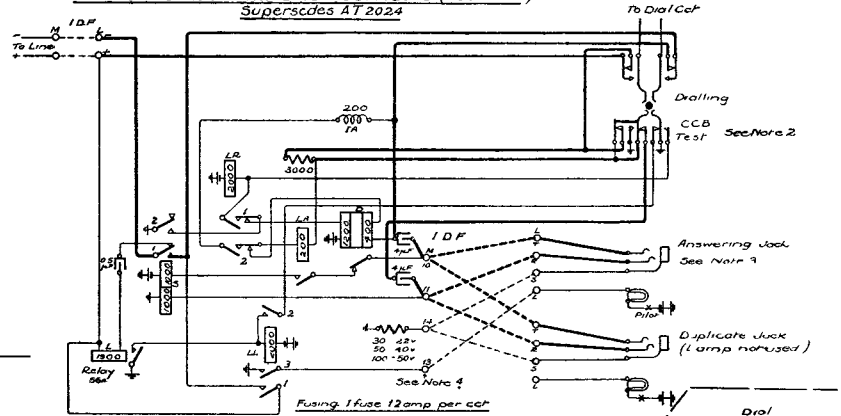
Auto Man Positions & C.B. Exchanges - AT 814
C.B.S. No 1 & 2 Exchanges - CBS 550
Magneto Exchanges - CBS 563

FIG. 3 CONNECTIONS FOR C.B.S. No 1 EXCHANGES



Note
The tags shown @ are terminals on the unit

FIG. 5 C.B. & AUTO-MANUAL POSITIONS (See Note 1)
Supersedes AT 2024

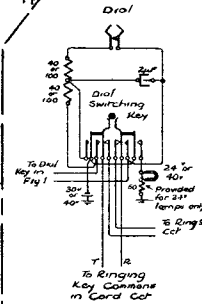


Note 1 Fig 2 can also be made to apply to C.B. Exchanges where it is desirable to use Unit Aux App No 60
In all other cases this figure (No 5) will be used in C.B. Exchanges

2 The Dialling & CCB Test Key will be fitted so that the lever is moved upward for dialling and downward for CCB test

3 Where one strip of lamps and jack is used solely for Rural Auto Eqpts the two jacks may be directly connected to each other on the strips instead of by jumpers

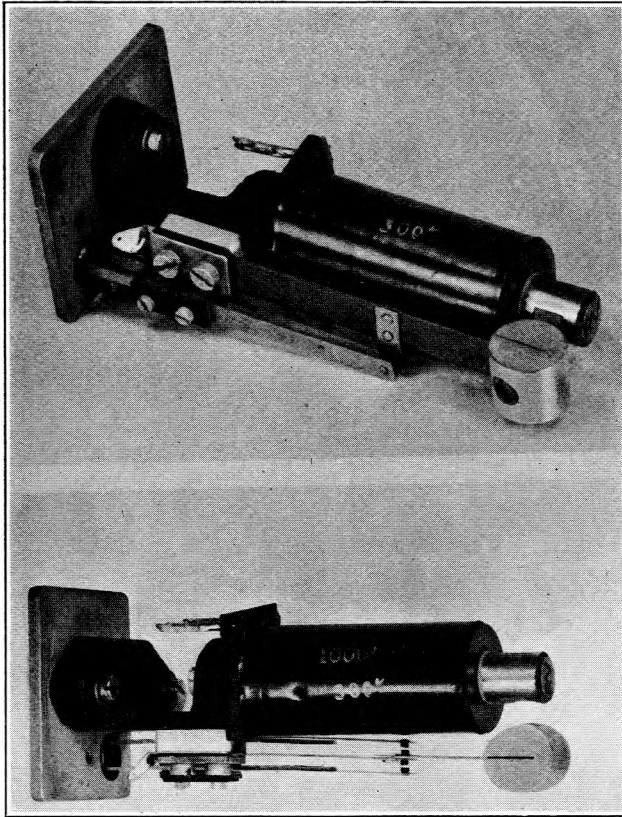
4 The figs shown against the tags are for identification with those on Figs. 1 & 2 which may be taken as explanatory to this figure on general principles



For C.B.S. No 2 Exchs see diagram CBS 560 C

FIG. 6 DIAL SWITCHING KEY CONNS IN GB EXCH WITH BATTERY DIALLING

JUNCTION (PARENT EXCHANGE) TERMINATIONS.



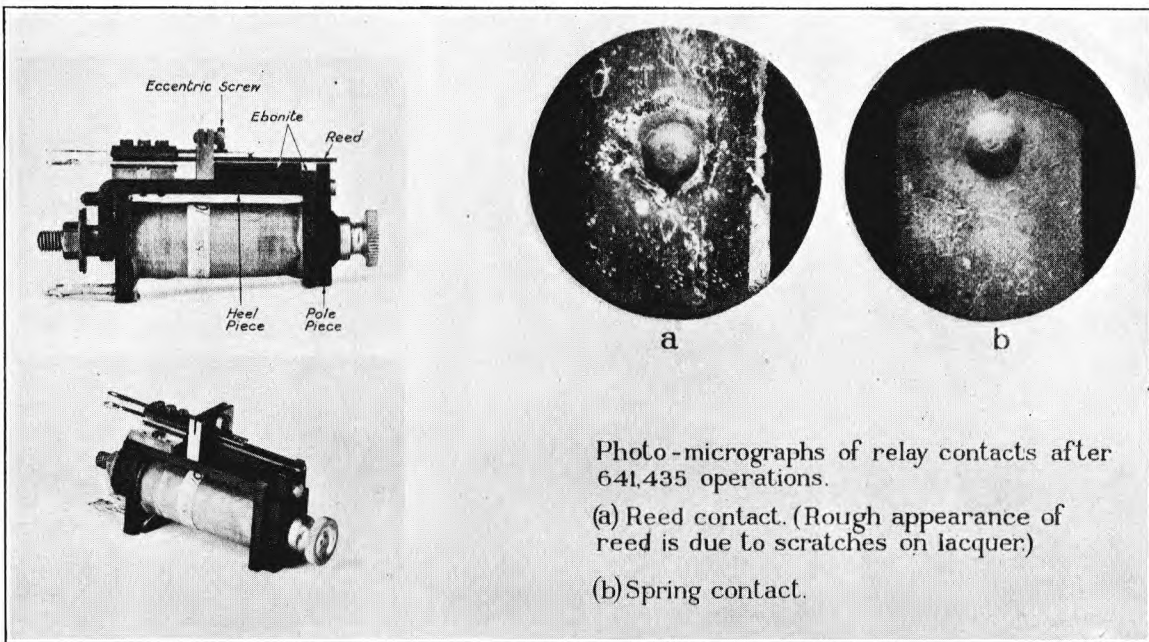
RINGING VIBRATOR.

FIG. 6.

so that the gap between it and the reed can be varied, and further adjustment is provided by an eccentric screw acting on the contact spring.

The photo-micrographs show that the contact wear is negligible, especially when it is realised that during each one of the operations the circuit of the relay on test was closed for $\frac{3}{4}$ of a second so that the reed vibrated about 300 times. Many millions of makes and breaks were therefore made by the contacts. The actual length of the relay is $3\frac{1}{4}$ inches.

Fault test circuit. At given intervals during the day parent exchange dials the test number, 99. The positive multiple bank contact of this circuit is wired to relay FT,



TONE BUZZER.

FIG. 7.

(see Fig. 4). which operates. The ringing and tone apparatus is started and, provided the undermentioned faults do not exist, ringing tone of $\frac{2}{3}$ second tone, $\frac{1}{3}$ second silence, is heard

via the contacts of relays FA and RA, relay FT functioning as an induction coil.

If a fuse is blown, relay FA operates and NU tone is substituted for the ringing tone. Similarly, if a switch fails to release or if earth is received from the power panel owing to failure of the charging plant, relay RA operates and again causes NU tone to be transmitted.

The majority of details which call for special notice have been mentioned and the power plant will now be dealt with.

Power Plant.

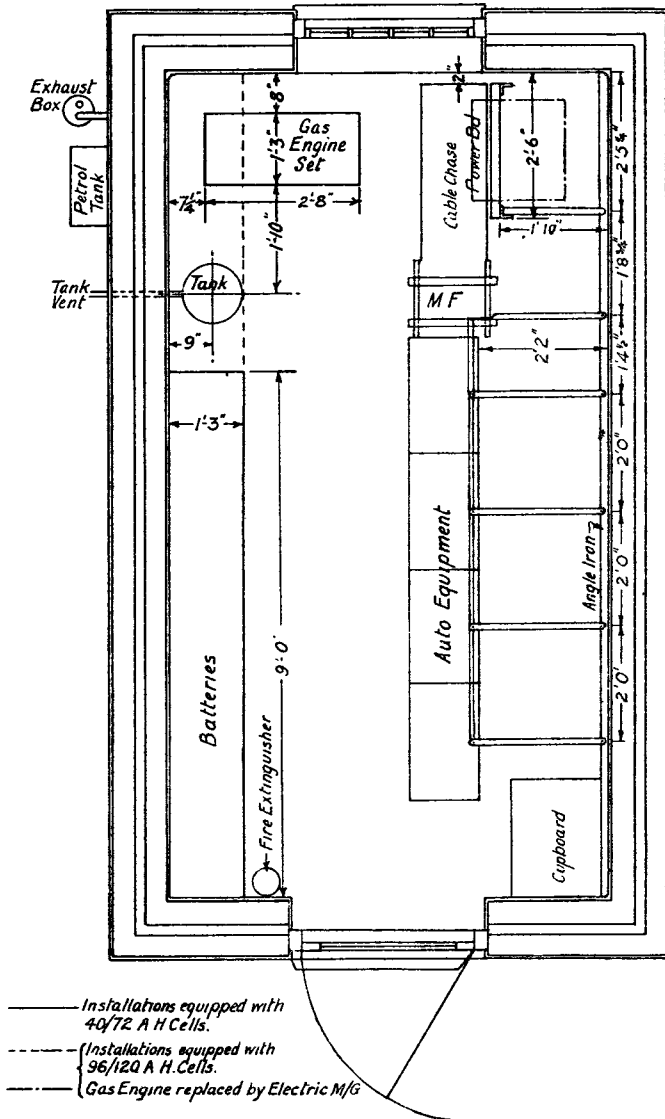
This consists of two sets of 25-40 amp. hour secondary cells, a power board and a charging device. Where a public electricity supply is available a dynamotor or Tungar rectifier is fitted, but where there is no such supply a 1 H.P. petrol engine charging set is installed. The latter type has so far been employed at about 85% of exchanges. In all cases the plant is started manually, but is so arranged that charging ceases automatically when a pre-determined number of ampere hours has been passed into the cells. This is accomplished by means of an ampere hour meter which either releases a circuit breaker in the case of an electricity supply or operates a needle valve in the petrol tank when an engine charging set is installed. Experience shows that a full battery charge will run a 12 line exchange for about a month.

Lay-out of Equipment.

Fig. 8 shows the standard lay-out of the equipment in a four unit rural auto exchange. The internal dimensions of the building are 14 ft. \times 7 ft. 6 ins. The lead-in cable enters by means of a small cable chase, and terminates on fuses on the lower half of a small floor type of main frame. Cables from the units terminate on arrestors on the upper half of the frame, both the lead-in and the unit cables being enamelled and lead covered.

Standard Buildings.

Housing of the equipment. In view of the type of apparatus installed it is essential that the building be as damp proof as possible, but continuous internal heating cannot be considered for economic reasons. It was therefore decided to retard the rate of change of temperature inside the



LAY-OUT OF EQUIPMENT.

FIG. 8.

building as much as practicable by means of double, cavity brick walls, so that when the temperature of the outside air falls, with the possible formation of mist and dew, the air inside the building by retaining its heat renders the deposition of moisture unlikely. The automatic apparatus has the further protection of its double walled cabinet. The building is provided with a concrete floor and a slated roof lined with matchboarding. Fig. 9 shows the outside views of a standard building. Local objections have occasionally been raised against the plainness of the building and in order to improve the external appearance evergreen shrubs and rambler roses are sometimes planted in the front of the site. In order to preserve local amenities the building itself may be cement-faced and lined to resemble stone blocks, or a "rough-cast" finish applied.

During the progress of these exchanges it has been found necessary to provide specifications for buildings constructed of stone instead of brick. These are erected in places where stone is cheaper or where it is desirable to harmonise with other property in the neighbourhood.

Another modified specification is for buildings in areas liable to flooding. Fig. 10 shows two elevations of such a building.

Site.

A site for the exchange, measuring 60 ft. \times 20 ft., is specified in order to allow for future extension, in which case an additional building would be erected end on to the existing one.

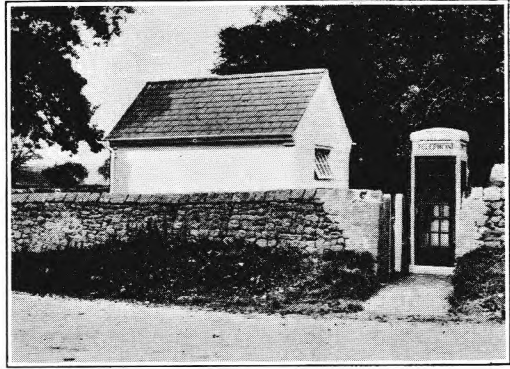
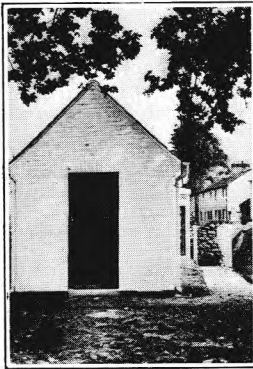
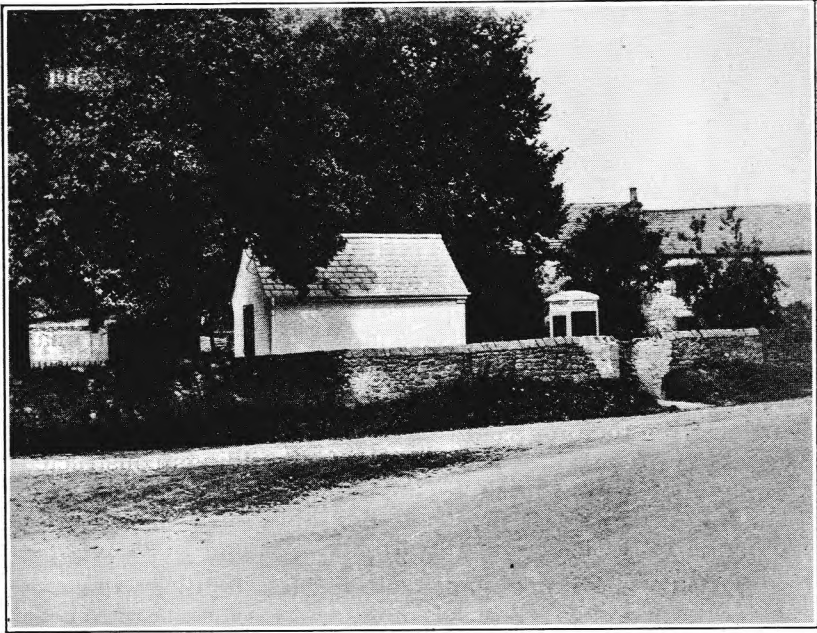
Call Office Kiosk.

A call office kiosk containing a prepayment multi coin box is provided on the site in the majority of cases, local calls being obtained automatically and junction calls *via* the parent exchange.

A modification to the coin box apparatus is necessary in order to allow the dialling code of the parent exchange (01) to be transmitted without inserting coins. This is effected by the addition of a slow-releasing relay to the coin box equipment (Fig. 11).

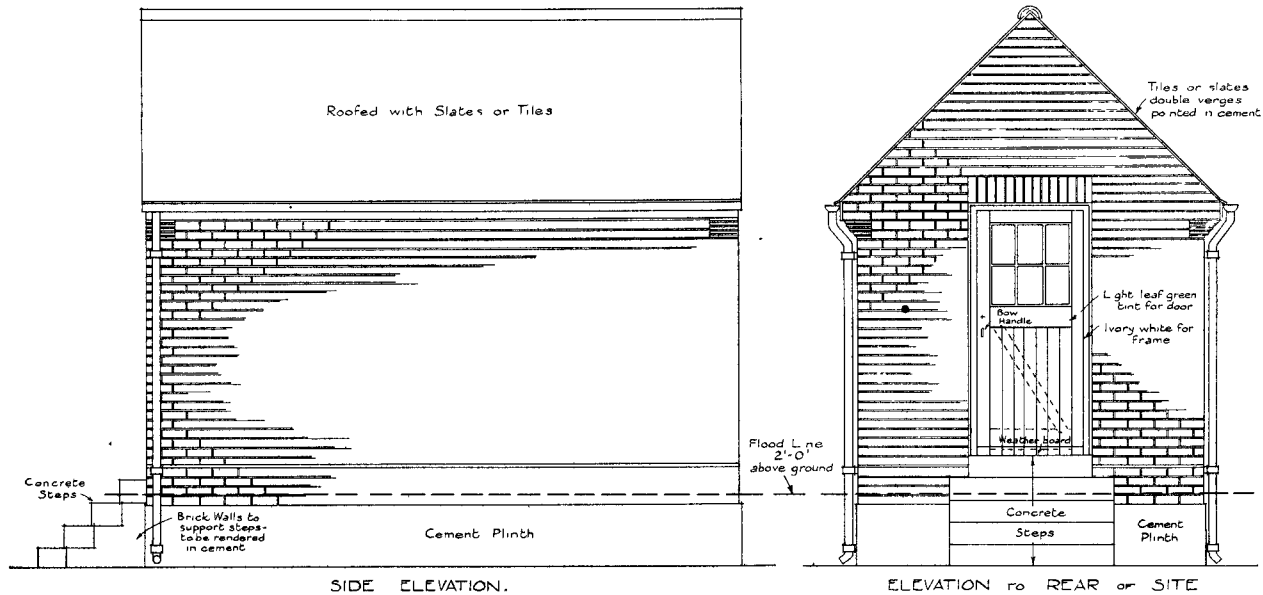
Installation and Maintenance.

The present policy regarding the provision of a rural



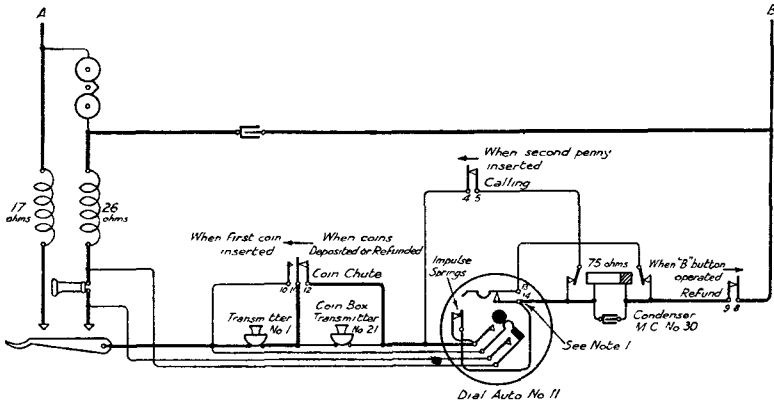
TUNSTALL RURAL AUTO. EXCHANGE BUILDING.

FIG. 9.



BUILDING FOR AREA SUBJECT TO FLOODING.

FIG. 10.



Note 1 When 0 is dialed i.e. when dial is revolved to its full extent, contacts 13 & 14 are opened and remain so until end of tenth impulse and then close

COIN BOX CIRCUIT.

FIG. 11.

automatic exchange is that when six prospective subscribers are obtained, the engineer recommends a suitable site for the contemplated exchange. When eight subscribers are secured the building is erected by a contractor under local supervision and all the equipment is installed by the local engineering staff.

On the average the purchase of a site occupies three months, building operations a further six weeks, and installation of the equipment six weeks, thus making about six months from the date of authorisation to the opening of the exchange. Line plant, if necessary, is put in hand coincident with the commencement of the building.

Maintenance is carried out as part of the duties of the workman in whose district the exchange is situated. Fort-nightly routine tests occupying just over an hour are made, faults being dealt with in the usual way.

Two simple testing sets are provided. One is used for making tests on the auto equipment, and consists of a small box containing a dial and a few keys, by means of which various conditions can be imposed on the automatic appar-

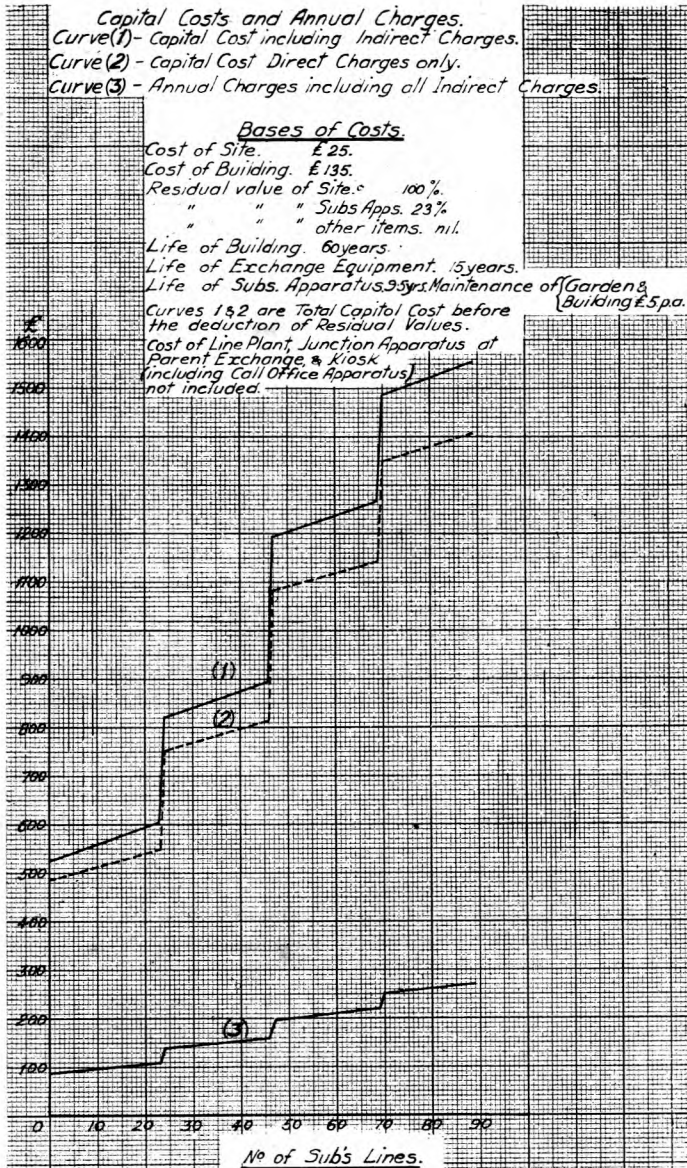
atus; this tester is portable. The other set is arranged for line testing. It is also in the box form and is equipped with a simple line testing circuit. When making tests the lineman places his Detector No. 4 into a compartment provided for the purpose. There is also room for a dial speed tester to be fitted on the front of the case, this facility being required only occasionally when dial speed tests are made.

The line tester is associated with a service telephone and the two items are mounted on a baseboard and fitted on the left side of the main frame.

At the inception of the scheme it was realised that the average lineman on a mixed duty in a country district would have neither the knowledge nor experience necessary to maintain automatic apparatus, that he was in a much more difficult position than the town man who, in most instances, had more experience of circuits, and further, could obtain assistance when needed for an intricate fault. Courses on rural automatics were, therefore, instituted at the Engineer-in-Chief's Training School at an early date, the object being to ensure that every man who is to be responsible for one of these exchanges shall receive instruction before taking it over. Further, to make certain that the standard methods of installation and maintenance are followed, a course for inspectors—one from each District—has been given, in which every phase in the progress of the rural automatic exchange was dealt with.

Costs.

In considering the rural automatic exchange there is one question which overshadows all others. I refer to capital costs, and the consequent annual charges. These are best illustrated by a curve (Fig. 12) showing the costs and charges involved from the initial to the ultimate capacity of the exchange. The initial cost, excluding line plant but including site and building, is say £500. The cost of additional subscribers' telephones causes the curve to slope a little until 23 subscribers are reached, when a second automatic unit causes a jump to about £800. At 46 subscribers a larger increase is incurred owing to a further unit and larger secondary cells being required. When the number of subscribers reaches 69 the fourth unit is fitted, and the total cost of an exchange with its complement of 89 subscribers is about £1,500.



COSTS AND ANNUAL CHARGES.

FIG. 12.

The annual charges follow on somewhat similar lines, in the initial case being about £85 and the final about £270.

Cost Comparison with Rural Manual Exchange.

In comparison with the rural manual exchange it would appear, at first sight, that the automatic exchange is a poor proposition on economic grounds. When, however, the problem is considered from all points of view it is thought the automatic plant can at least hold its own. In the first place the automatic exchange provides continuous service; the cost of this, manually, would be very great. Secondly, the automatic building will probably accommodate the exchange for 30 years, and there can be little doubt that manual equipment would be the subject of more than one expensive transfer during that time owing to expansion of the equipment, or operating problems. Thirdly, the cost of accommodation, which is clear for the automatic exchange, is obscure in the manual case, for it is difficult, if not impossible, to extract the charges due to the larger premises, etc., which are necessitated by the inclusion of a manual exchange in a small post office.

It would, of course, be futile to attempt to justify rural automatic plant at the commencement when a capital cost (excluding line plant) of about £550 and annual charges of about £95 are incurred for eight subscribers. At that stage we must regard the exchange as an enterprise in the same light as a tube railway extension to a thinly populated suburb or the erection of a block of flats; that is, that the supply of something better, an improved service, although run at a loss at first when patronage is small, will create its own demand, grow in popularity and become a profitable business. That may seem an optimistic and somewhat unusual view to take in the telephone world, but results appear to be justifying it, for a number of cases have occurred in which eight subscribers have been forthcoming at the beginning and six months later at the opening of the exchange this has been increased by 50%. Further encouragement has also been given to rural telephone development by the increase of the free radius from $1\frac{1}{2}$ to 2 miles. Also, apart from the question of profit the Department is bound, in its capacity of providing a public service, to cater for the requirements of rural as well as town communities by installing up-to-date equipment.

Progress of Scheme.

The progress of these exchanges has been remarkably rapid. The first one was brought into service on February 4th, 1929, and over 100 were opened in all parts of the country during the following 12 months, the great majority being entirely new exchanges. The rate of increase is growing, and in addition to those already in service, there are about 150 in course of installation.

Development of 200 line Rural Auto Exchange.

The scheme has grown so rapidly that a rural automatic exchange with a capacity of 200 lines is being developed. Two more important facilities will be included, viz., auxiliary P.B.X. lines and an "all links busy" tone. It is not proposed that the new type should supersede the existing scheme up to 100 lines, but to cater for those areas which contain P.B.X.'s or in which the development is too high for the 100 line scheme to be employed initially.

In conclusion, this branch of automatics may be regarded as a very vigorous and robust offspring which is growing quickly and will soon become no inconsiderable part of the automatic telephone system of the country.