scheme, it is necessary to arrange that the three code letters dialled by a subscriber shall be translated into the necessary sequence of impulse trains required to reach the objective exchange. Where heavy traffic exists between two exchanges, direct routing may be adopted, but where the traffic is light, it may be routed to a Tandem exchange, where, joining similar traffic from other exchanges, it is routed over outgoing junctions to the objective exchange. There are various types of apparatus in use for effecting this translation, but the one adopted by the British Post Office is known as the Director. The circuits used in connexion with the director are dealt with in the succeeding chapter.

Due to the introduction of an exchange code translation scheme, some additional nomenclature is necessary to simplify the identification of the selectors used in a chain of connexions. The three code letters dialled by a calling subscriber are known as the A, B, and C digits respectively, whatever their alphabetical order may be; thus, in the case of Harrow, H is the A digit, A the B digit, and R the C digit. The selectors which respond to the code letters dialled by a calling subscriber are known as the A-digit selector and the BC selector; the latter forms part of the director. The selectors which respond to trains of impulses forming a code as translated by the directors are known as first, second, etc., code selectors. The selectors in the Tandem exchange, which is merely concerned with junction switching and has no subscribers connected to it, are known as first, etc., Tandem selectors. The selectors which respond to the four digits of the called subscriber's number are known as first and second numerical selectors and final selectors. In certain circumstances, third numerical selectors may be used to give access to large P.B.X. groups. The final selectors are similar to those described in Chapter VI, and, with the exception of the A-digit selector, the BC selector in the director, and the first code selector, the rest of the selectors are similar to the group selector already dealt with on page 209.

CHAPTER VIII

THE DIRECTOR SYSTEM

The Principle of the Director System. In a large multi-exchange area in which the director is used, the calling subscriber dials the first three letters of the name of the exchange required, followed by the four numerical digits forming the called subscriber's number. The first portion, consisting of the *A*, *B*, and *C* digits, is known as the code portion, and is translated

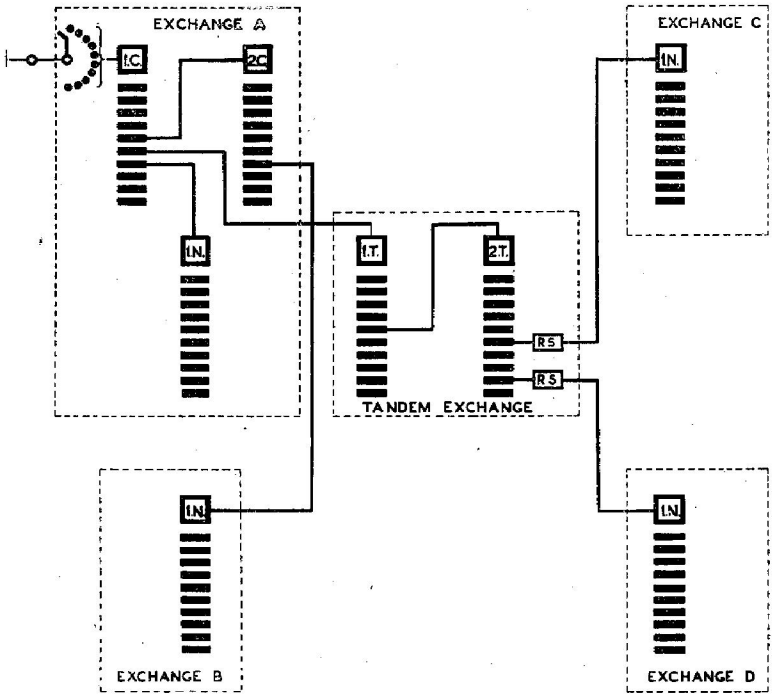


FIG. 199. TRUNKING SCHEME WITH TRANSLATION

by the director into the necessary trains of impulses, as required by the junction network and junction switching scheme to route the call to a first numerical selector in the objective exchange; the second portion, consisting of a 4-digit number, is known as the numerical portion, and this is stored by the

director until the translation of the code portion has been sent out, when it is transmitted exactly as received from the calling subscriber, i.e. without translation.

The principle of the trunking scheme rendered available by the use of a code translation device is shown in Fig. 199, which is based upon the junction lay-out shown in Fig. 200. The 1st numerical selectors in exchange *A* are reached from level 4 of the first code selectors in that exchange; a director in exchange *A* is required, therefore, to translate the code portion dialled by a subscriber calling another subscriber connected to exchange *A* into a single train of four impulses. In order to reach a junction outgoing from exchange *A* to the 1st numerical selectors in exchange *B*, the digits 6 and 4 are required to step the first and second code selectors in exchange *A*; thus a director in exchange *A* is required to translate the code portion dialled by a subscriber connected to this exchange, when calling a subscriber connected to exchange *B*, into two trains of impulses for the digits 6 and 4 respectively. Subscribers connected to exchanges *C* and *D* are reached *via* a junction to the tandem exchange, and thence over a junction outgoing from that exchange to the particular exchange required. The tandem exchange is so named because it occupies a position, on every call passing through it, in tandem or in series. The digit 5 is required at exchange *A* to step the first code selector and obtain a junction to the tandem exchange; to reach a 1st numerical selector in exchange *C* the digits 6 and 5 are required to step the first and second tandem selectors. Thus, when a subscriber connected to exchange *A* calls a subscriber connected to exchange *C*, a director in exchange *A* is required to translate the code portion dialled into the digits 5, 6, and 5. In the case of a call from exchange *A* to exchange *D*, the digit 5 is again required to obtain a junction to a first tandem selector, but digits 6 and 2 are now required to step the first and second tandem selectors to obtain a junction to exchange *D*; that is, the translation required in this case is 562.

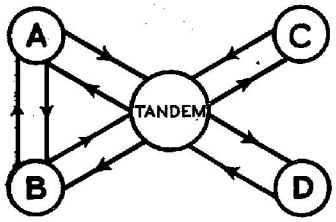


FIG. 200. JUNCTION LAYOUT FOR FIG. 199

The translation scheme will be made more clear if names are allotted to the exchanges, and this has been done in the following table, which shows the translations required by the

junction scheme of Fig. 200 and the trunking scheme of Fig. 199 when a subscriber connected to exchange *A* calls a subscriber connected to any one of the four exchanges.

Letter	Exchange Name	Code Dialled	Numerical Equivalent	Translated to
A	MAYfair	MAY	629	4
B	PADdington	PAD	723	64
C	POPesgrove	POP	707	565
D	NEW Cross	NEW	639	562

To render the junction scheme as flexible as possible, the director is arranged to translate any given code into 1, 2, 3, 4, 5 or 6 separate digits as may be necessary.

It will be seen later that the first code selector contains a transmission bridge, and as a result the need for a junction relay-set in junctions outgoing from a director exchange to another automatic exchange is obviated. This is seen in Fig. 199, where the only exchange equipped with outgoing junction relay-sets is the tandem exchange, which is, of course, simply a junction-switching centre employing two-motion selectors to effect the necessary switching operations.

Comparing the trunking scheme available when a translation device, such as the director, is used with that required by a three-letter code scheme without translation, as shown in Fig. 198, it is seen that two ranks of selectors are saved on a call local to a particular exchange; the junctions to nearby exchanges are reached by two translated digits, instead of three code digits, resulting in a saving of one rank of selectors. It is now possible to make use of tandem switching centres, and thereby obtain the advantages attendant upon the use of a large group of junctions carrying traffic to the tandem centre, whence it is distributed to a number of other exchanges; similarly the traffic from other exchanges to an exchange reached *via* the tandem exchange is collected at the tandem exchange and routed over one large group of junctions to the exchange required. As a result, the traffic-carrying capacity of each junction is higher than would be the case if direct junctions were provided from each exchange to every other exchange in the area, as was required by the three-letter code without translation. It will be readily appreciated that the saving in junction cable effected by the use of a translation scheme is very large.

The relation of the director with the setting up of a through connexion is shown in Fig. 201. When a calling subscriber removes his receiver, the hunter or line finder associated with his line searches for and seizes a disengaged first code selector; this selector is to respond to the first digit of the translation sent out by the director at a subsequent stage. Cabled to each first code selector is an A-digit selector hunter, which is a uniselector. Immediately a first code selector is seized, its associated A-digit selector hunter hunts for and seizes a disengaged A-digit selector (A.D.S.), that is a selector which is to respond to the A-digit dialled by the calling subscriber. Dialling tone

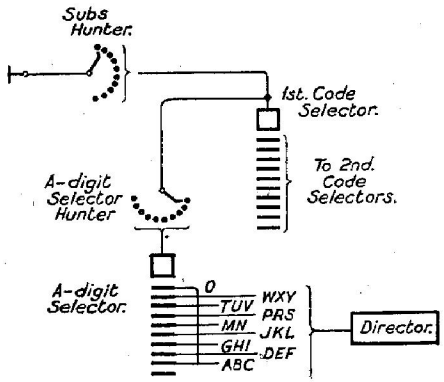


FIG. 201. DIRECTOR TRUNKING DIAGRAM

is returned to the calling subscriber from the A-digit selector. The circuit arrangements are such that immediately the director has received the B and C digits it commences sending out the translation required, without waiting for the complete reception of the numerical portion. By this means, the time for which a director is in use on a call is reduced. In order to effect this, it is necessary to provide two separate impulsing paths, one outgoing from the director to the first code selector, and thence to the junction network, and the other outgoing from the 1st code selector to the director. The director sends out standard loop impulses, and consequently two wires are needed for the transmission of these; a private wire providing for the usual guarding and holding conditions is necessary; a fourth wire, known as the pulse wire, provides the second impulsing path.

The calling subscriber dials the A-digit, which is received

by the first code selector; this selector does not step at this stage, but repeats the impulses to the A.D.S. over the pulse wire. The A.D.S. rises to the level corresponding to the A-digit dialled and searches over that level for a disengaged director serving the group of exchanges containing the one required. The B, C, and four numerical digits are received by the first code selector, and repeated into the director over the pulse wire, which has been extended by the A.D.S. The operation of receiving the impulses from the calling subscriber's dial, which are repeated over the pulse wire by the first code selector, is known as pulsing-in, whilst the operation of sending out the required translation followed by the four numerical digits is known as pulsing-out. Immediately the B and C digits have been pulsed in, then the director commences pulsing out the translation, and after this stage pulsing-in and pulsing-out proceed simultaneously. The first train of impulses pulsed out steps the first code selector; if the call is a local one, then the director next sends out the numerical portion as each digit is completely received and stored in the director. If the translation required is more than a single digit, then the director pulses out up to a maximum of six trains of impulses before sending out the numerical digits received from the calling subscriber and stored in the meantime.

When the director has completed pulsing out, the A.D.S. and the director are released and become available for routing another call; the calling subscriber is now through, as shown in skeleton in Fig. 199, and he receives one or other of the tone signals from the selectors forming the through connexion. The director is actually in use for about 18 seconds on each call, and is concerned only with the routing of calls. Under normal conditions, a director will deal with some 150,000 calls per annum. The number of directors required in an exchange is computed on the basis of the holding time given above.

It will be appreciated that if a subscriber causes a director to be held for an unduly long period, due to dialling an incomplete number or any other misoperation on his part, then other subscribers may be prevented from making a call, owing to the increased possibility that all the directors to which they have access are engaged. To reduce the possibility of such an occurrence, the director is arranged to apply a forced release after it has been held for a period of from 30 to 60 seconds; the A.D.S. and director are released and N.U. tone returned to the calling party from the first code selector.

No letters are allotted to the hole in the dial finger plate coinciding with the digit 1, on account of the possibility that a calling subscriber may reach level 1 due to depressing his receiver switch-hook momentarily whilst removing the receiver prior to making a call. It has been seen that in a non-director exchange such misoperation on the part of the calling subscriber results in the reception of N.U. tone from level 1 of the first group selector, but in a director exchange the *A*-digit selector is arranged to absorb digit 1 and function in the ordinary way subsequently; thus in a director exchange a subscriber's misoperation of this character is corrected. The single digit 0 is used for calls to an operator at the manual board; consequently the letter *O* can never be the first letter, i.e. the *A*-digit, of an exchange code. Accordingly the directors are divided into eight groups, as shown in Fig. 201; a director reached from level 2 of an A.D.S. will deal with calls to all exchanges whose names commence with the letters *A*, *B*, or *C*, and similarly for the remaining groups. A three-letter code is allotted to the special services, TRU for Trunk calls, TOL for Toll calls, DIR for Directory Enquiry, since the absence of the letter Q from the dial renders the code ENQ unavailable, and so on. Calls to a special service are known as Code Only calls, since only the code is dialled and no numerical digits are received from the calling subscriber. The limitation in the use of levels, which, in a non-director exchange, reduced the actual capacity of a 4-digit system to 7,000 lines, is now seen to affect the code portion of calls, and not the numerical portion; hence the size of the 4-digit exchanges in a director area can be the maximum available with 4-digit numbers, that is, 10,000 lines.

The First Code Selector. When a calling subscriber removes his receiver, the hunter or line finder searches for and seizes a disengaged first code selector and associated *A*-digit hunter. This hunter is a uniselector and has 24 trunks outgoing to *A*-digit selectors. It is arranged to return its wipers to their home position when the calling subscriber replaces the receiver. The first code selector comprises the usual 2-motion mechanism and a relay group which contains a transmission bridge. Since the impulses outgoing to the junction network are derived from the director, the relay which feeds current to the calling subscriber's transmitter can be arranged to provide holding and guarding conditions on the *P*-wire within the exchange. The first code selector is also designed to effect metering from

the battery reversal received when the called subscriber replies. Consequently, a junction relay-set is not required in the junctions outgoing from the exchange to other automatic exchanges.

The functions performed by the first code selector are as follows—

(i) Holds the connexion under the control of the calling subscriber.

(ii) Completes a circuit for the *A*-digit hunter to hunt for and seize a free *A*-digit selector.

(iii) Extends the pulsing-in and pulsing-out wires to the *A*-digit selector.

(iv) Repeats the impulses, dialled by the subscriber, into the *A*-digit selector and the director.

(v) Steps vertically under the control of the 1st train of impulses received from the director.

(vi) Hunts for and seizes the first free outlet and extends the pulsing-out wires to the next selector.

(vii) Transmits busy tone if all the outlets are engaged.

(viii) Switches the circuit through when the director has transmitted the last train of impulses.

(ix) Provides a transmission bridge.

(x) Applies positive battery metering conditions when the called subscriber answers.

(xi) Provides manual hold facilities.

(xii) Provides re-ring facilities for calls to trunk demand positions.

(xiii) Provides a supervisory alarm under C.S.H. and "forced release" conditions.

(xiv) Provides for forced release under P.G., premature dialling, delayed dialling, or spare code conditions.

(xv) Provides an alarm should the selector shaft fail to release or the *A*-digit hunter fail to rotate.

The connexions of a typical 200-outlet first code selector are shown in Fig. 202. When the selector is seized, relay *L* operates; **L1** operates relay *A* and **L2** operates relay *B*. Relay *A* completes the circuit for the *K* relay of the *A*-digit hunter at **A2**, whilst **A1** prepares a circuit for relay *C*. Relay *B* operates and **B1** connects earth to the incoming *P*-wire (i); **B2** closes the circuit of relay *C*; **B3** prepares the metering circuit. **C1** disconnects the release magnet; **C2** closes a circuit for relay *MG*, which, at this stage, acts as a testing relay for the *A*-digit hunter; **C3** prepares the vertical magnet circuit for operation

later when the director pulses out; **C4** prepares a circuit for the operation of relay *M* under premature dialling conditions; **C5** prepares a circuit for the *A*-digit hunter driving magnet. Relay *MG* operates and **MG1** closes the circuit of the

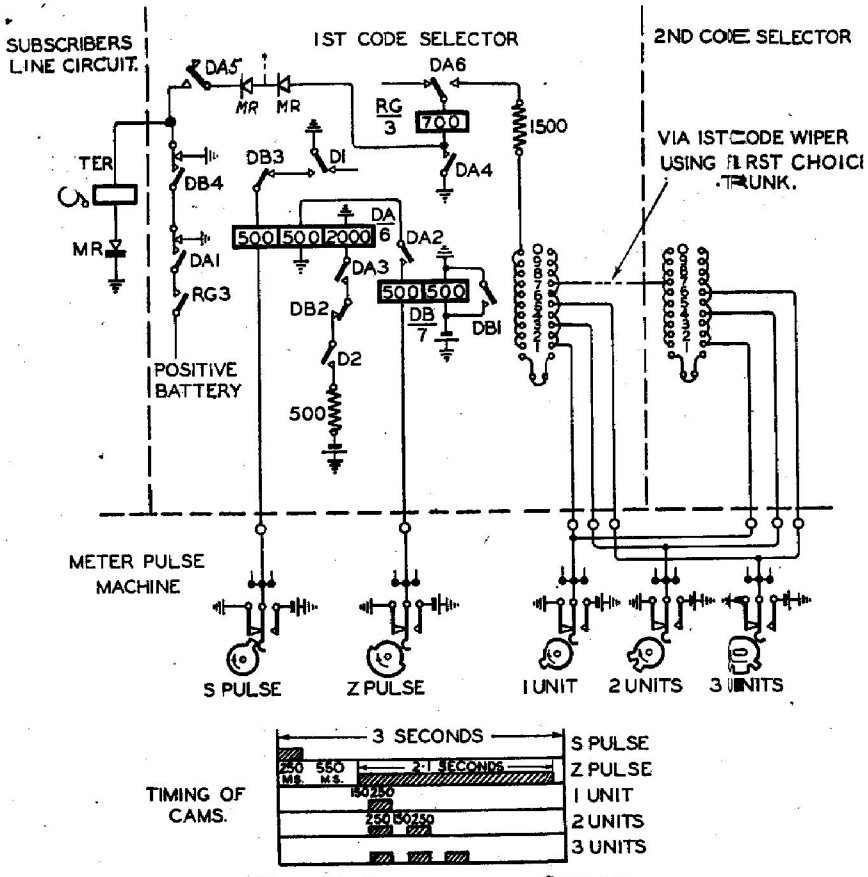
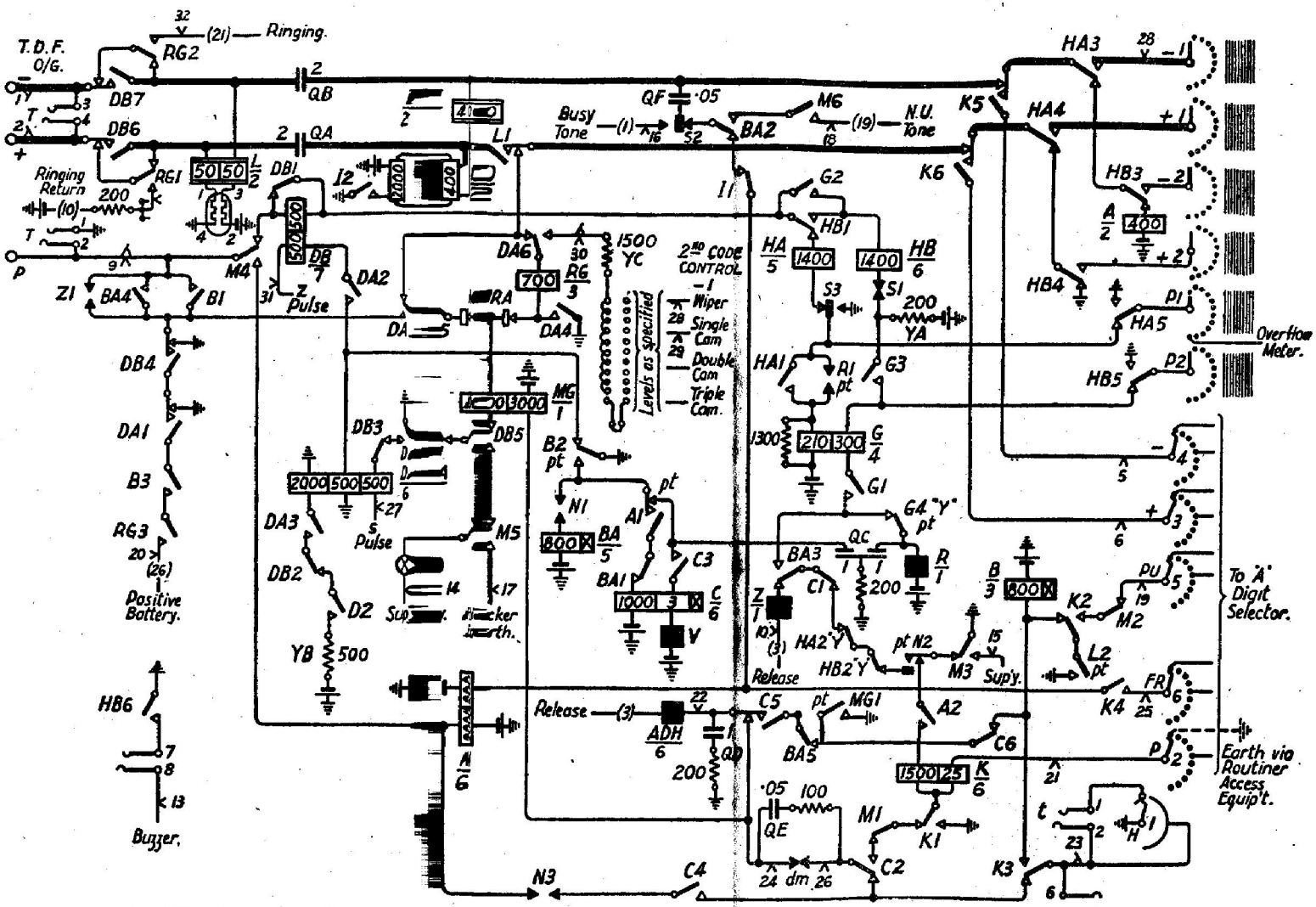


FIG. 203. MULTI-METERING CONTROL

driving magnet, stepping the wipers of the *A*-digit hunter to the bank contacts of the first trunk (ii); the home bank contacts of the *A*-digit hunter are connected to the routiner, the *P*-wire being earthed through the routiner access equipment. Relay *MG* releases when its circuit is broken by the interrupter springs and disconnects the driving magnet. When the *dm* springs make contact on the release of the driving



(T.5070) FIG. 202. 200-OUTLET FIRST CODE SELECTOR WITH MULTI-METERING AND BALLAST RESISTANCE IN TRANSMISSION BRIDGE 310

magnet, relay *MG* is extended through **C2,** *M*1, *K*1, 25-ohm coil of relay *K* to the *P*-wire of the *A*-digit hunter; if the outlet is busy, relay *MG* operates and the cycle of operations just described recurs. When the wipers step on to the bank contacts of a free outlet, the *P*-wiper encounters battery through 400 ohms; relay *K* now operates through both coils in series through **A2,** *N*2 and *M*3; **K1** locks the relay on its 25-ohm coil; **K2** disconnects relay *B* and connects earth to the pulse wire through *M*2; **K3** connects earth from the homing arc to retain relay *B*; **K4, K5,** and **K6** switch the forced release and the negative and positive wires through (iii). Relay *A* is now retained by a loop on the negative and positive wires in the *A*-digit selector, from which dialling tone is extended over the forced release wire through **K4,** *I*1, *BA*2, *S*2 to the negative wire and thence to the calling subscriber's telephone.

The circuit is now prepared for the reception of impulses, and the impulsing of contact *L*2 sends earth pulses over the pulse wire to the *A*-digit selector and, later, to the director, (iv).

At a later stage, the director pulses out the translation and the first train of impulses causes relay *A* to impulse. With the first release of relay *A*, the vertical magnet circuit is closed (v) and, when the wipers move off-normal, **N1** closes a circuit for relay *BA*; **BA1** disconnects the operating circuit of relay *C*; **BA2** prepares a circuit for N.U. tone under forced release conditions; **BA3** disconnects the release magnet and prepares a circuit for the rotary magnet; **BA4** connects earth to the incoming *P*-wire. The effect of relays *B* and *BA* is to provide a guarding period equal to the sum of the release lags of these two relays on the incoming *P*-wire, to enable the selectors at other exchanges in the chain of connexions to be released before the first code selector is released.

On the completion of the vertical movement, relay *C* releases and *C*1 closes the circuit of the rotary magnet. The selector is of the 200-outlet type and relays *HA* and *HB* test the outlets in succession, operating in conjunction with relay *G*, which effects the operation of the rotary magnet in the event of both outlets being engaged (vi). This portion of the circuit follows the principles already given on page 220.

On the completion of the trains of impulses pulsed out from the director, the battery connected to the *P*-wire in the director is disconnected and relay *K* releases; *K*5 and *K*6 switch the incoming negative and positive wires to the outgoing negative

and positive wires (viii). Relay *I* now operates from the current flowing in the loop and **I1** disconnects the tone condenser; **I2** polarizes relay *D*. The release of relay *K* closes the homing circuit for the *A*-digit hunter at *K*3, and the wipers are stepped round to their home position.

Single and Multiple Metering. At a subsequent stage the called subscriber answers and relay *D* operates to effect metering conditions (x); **D1** connects one coil of relay *DA* to the *S* pulse, and **D2** connects battery to *DA*3 in readiness for holding relay *DA*. The circuit shown in Fig. 202 provides for single or multiple metering facilities at will. In the event of a call within the unit fee area, the meter is operated once, but for calls to the 2d. or 3d. fee areas, the meter must be operated twice or thrice as required; the circuit elements for the metering condition are shown in Fig. 203, which also illustrates the method of providing control of the metering by a second code selector instead of a first code selector. In these conditions, the second code control wire of Fig. 202 is connected to jack point 28, i.e. the – 1 wiper, and to the specified levels on the vertical marking bank, the *P*1 outlets on these levels being earthed. In the second code selector, the – 1 wires are connected to the *M* wire. By utilizing the – 1 wire in this manner, the availability of each level is reduced to 10 wherever second code selector metering control is provided. Reverting to Fig. 203, the operation of relay *D* in the first code selector prepares the metering circuit as already described, and with the first *S* pulse, relay *DA* operates; **DA1** prepares the metering circuit; **DA2** connects one coil of relay *DA* in series with one coil of relay *DB* to the *Z* pulse wire; **DA3** closes a retaining circuit for relay *DA* over its 2,000-ohm coil; **DA4** and **DA6** prepare a circuit for relay *RG* by extending this relay to the vertical marking bank contact. Some 550 mS after the completion of the *S* pulse, the *Z* pulse commences and lasts for 2·1 sec., as shown in the timing chart given in Fig. 203. Relay *DA* is retained for this period and relay *DB* is operated in series with relay *DA* through **DA2.** The short-circuit across the second coil of relay *DB* is removed at **DB1** to enable relay *DB* to hold in series with relay *HA* (or *HB*) throughout the call; **DB2** disconnects the holding circuit of relay *DA* whilst **DB3** disconnects the *S* pulse coil of relay *DA*; **DB4** further prepares a circuit for the application of positive battery to the *P*-wire; **DB5** disconnects relay *MG*; **DB6** and **DB7** maintain an alternative circuit for relay *L* while relay *RG* is operated.

Relay *RG* is now extended through the vertical marking bank and wiper to the appropriate metering cam determined by the level reached. During the 2·1 seconds of the *Z* pulse, single, double, or triple metering conditions are applied by the metering cams; relay *RG* is accordingly operated once, twice, or thrice. Contact **RG3** connects one, two, or three positive battery pulses to the *P*-wire to operate the subscriber's meter the equivalent number of times. In the condition shown in Fig. 203, levels 1, 2, 4, 6, 8, 9, and 0 of the first code selector are connected to the single unit pulse lead; level 3 is connected to the two units pulse lead, whilst level 5 is connected to the three units pulse lead. On level 7, control of the metering is effected by the second code selector, and the meter wire is extended through the vertical marking bank over the – 1 wiper to the vertical marking bank of the second code selector, where choice of the metering pulse required is made in the manner already described. A diagram of a second code selector providing multiple metering facilities in this way is given in Fig. 204.

Re-ring. The re-ring facility is required in the event of a call to a trunk demand position; in these conditions, the application of a 50-volt positive battery to the positive wire operates relay *RG*, which connects the incoming negative and positive wires to the ringing and ringing return circuits. Relay *MG* is held operated in these conditions and **MG1** closes a circuit for relay *B* to hold the connexion by the earth at **B1** (xii).

Forced Release. Should one or other of the following conditions arise during the setting up of a connexion, the selectors concerned are forcibly released and an alarm given; the conditions are—

(*a*) If the subscriber dials one or more digits and then fails to complete dialling within the period of the time pulse (see page 332).

(*b*) If the subscriber fails to dial any digits before the expiration of the time pulse.

(*c*) If the subscriber commences to dial before dialling tone is connected.

In condition (*a*), the director connects earth to the forced release wire on completion of the time pulse; this operates relay *M* and also disconnects the pulsing-out loop to release relay *A*; *A*1 causes the selector to take one vertical step, so operating the off-normal springs and relay *BA*. **M1** prevents the re-operation of relay *K* after it is released due to **M2,** which disconnects the pulsing-in wire, so releasing the director

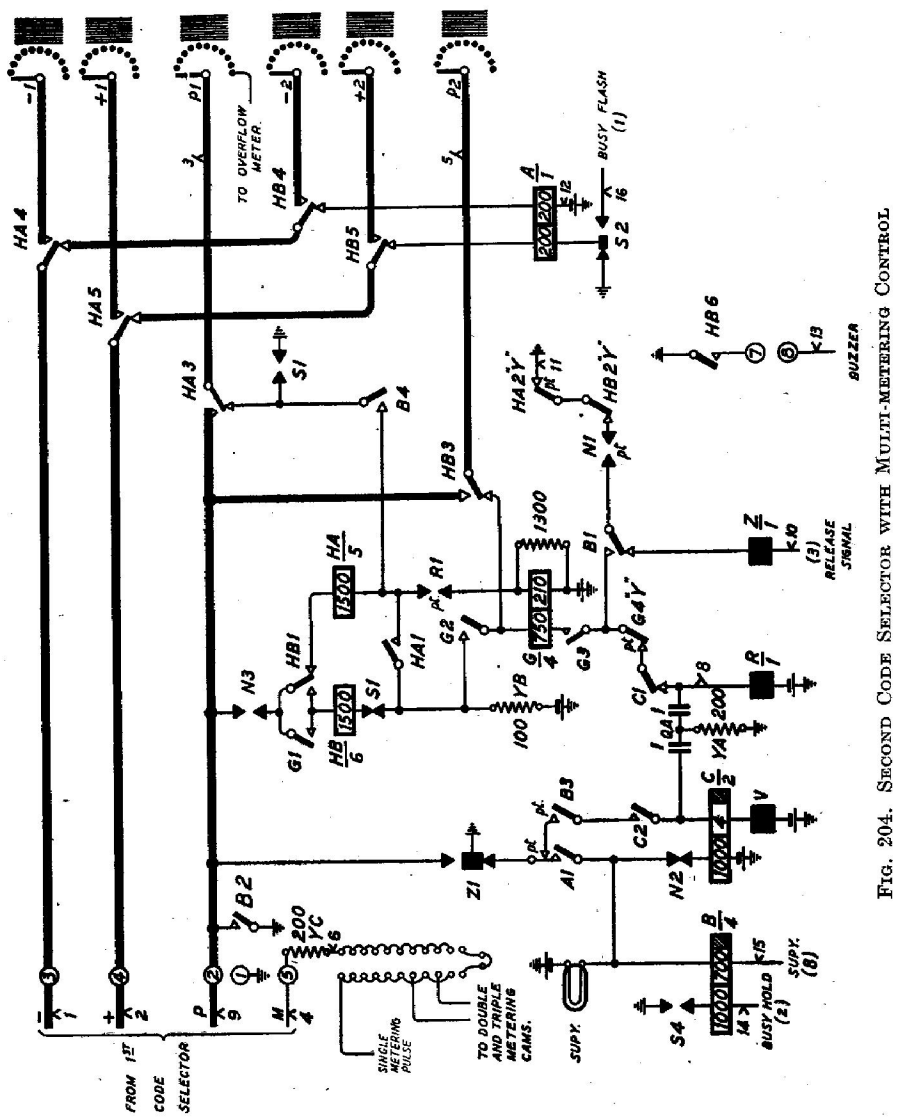


FIG. 204. SECOND CODE SELECTOR WITH MULTI-METERING CONTROL

which then removes the battery from the *P*-wire to release relay *K*; **M3** closes the supervisory circuit and also breaks the circuit of the rotary magnet to prevent rotary stepping; **M4** locks relay *M* to the *P*-wire, and releases relay *H A* or *H B* should the director have pulsed out any digits; **M5** disconnects the metering circuit and connects the supervisory lamp to flicker earth (xiii); **M6** closes the N.U. tone circuit *via* **BA2.** When relay *K* releases, relay *A* is re-operated by **L1,** and **A1** disconnects the vertical magnet and relay *C*. On the release of relay *C*, the homing circuit for the *A*-digit hunter is completed.

In condition (*b*), the operation is the same as for a permanent loop (see below). If the subscriber dials after the forced release has operated, the condition becomes the same as premature dialling.

In condition (*c*), relay *K* is unoperated and the uniselector is hunting. A circuit is thus completed for relay *M* from earth, homing arc, *K*3, **C4, N3,** 2000 Ω coil to battery. The contacts of relay *M* then function as described above (xiv).

Permanent Loop. In the event of a permanent loop, relay *L* operates and an *A*-digit selector is seized. The application of earth to the forced release wire by the *A*-digit selector operates relay *M*, and, with the release of relay *K*, an alternative circuit for relay *B* is closed through *K*2 and **L2.** Since relay *BA* has not been operated in these conditions, N.U. tone is not connected. The other conditions, however, are the same as just described, and the supervisory lamp flickers to indicate the existence of a fault (xiv).

Manual Hold. The manual hold condition is provided by relay *MG*. In the event of the subscriber replacing the receiver before the operator clears, relay *L* releases and the battery received over the positive wire operates relay *MG* through the metal rectifier shunting relay *RG*, *DB*5, and *D*1 to earth; **MG1** closes a circuit through *C*6 for the retention of relay *B* and **B1** maintains a guarding earth on the incoming *P*-wire (xi).

Second Code Selectors. These selectors are similar to the group selectors described on pages 209 and 218, except that dialling tone is not provided.

Where control of multiple metering is required in a second selector, then the circuit shown in Fig. 204 is used. This is similar to the 200-outlet group selector described on page 218, except for the addition of a fourth wiper and vertical marking bank for use in association with the metering condition. The

M wire is connected to the – 1 wiper of the preceding selectors, as shown in Fig. 203. The particular meter pulse required is connected to the M wire through the vertical marking bank, when the selector is raised to the level required.

A-Digit Selector. The functions performed by this selector are as follows—

(i) Transmits dialling tone to the calling subscriber.

(ii) Steps vertically under the control of the first code train of impulses from the subscriber's dial.

(iii) Hunts for and seizes a free outlet to a director.

(iv) Transmits busy tone if all outlets are engaged.

(v) Switches the pulsing-in, pulsing-out, forced release, and P-wires through to the director seized.

(vi) Disconnects dialling tone.

(vii) Connects an earth to the forced release wire for the forced release of the selector should the subscriber not commence to dial within a specified period (P.G. condition).

(viii) Provides for the release of the shaft if the digit 1 is received.

(ix) Releases when release conditions are applied by the director.

(x) Provides a release failure supervisory alarm.

A diagram of the connexions of the A-digit selector is given in Fig. 205. When the selector is seized, relay A is operated by the earth connected through the 25-ohm coil of relay K in the first code selector over the P-wire, $H6$, $N1$, and $B2$; **A1** closes a circuit for relay C and prepares for the operation of the vertical magnet. Relay C prepares for the first rotary step at **C1**; **C2** operates relay B; **C3** connects dialling tone to the forced release wire and thence *via* the first code selector to the calling subscriber's instrument (i); **C4** prepares a circuit for relay TP, which is concerned with the forced release of the connexion in the event of a failure to dial within the period of the time pulses; **C5** prepares the vertical magnet circuit.

Relay A in the first code selector is held by the 500-ohm loop across the negative and positive wires through $H5$.

Forced Release. Under P.G. conditions, the faulty line will cause a first code selector and A-digit selector to be seized; an impulse train is not received and it is necessary to arrange for the A-digit selector to be released after an interval. This is effected by relays TP and G (Fig. 206). When the first S pulse is received, relay TP operates and locks through **TP3**; **TP1** disconnects the rotary magnet; **TP2** prepares a circuit for

the application of earth to the forced release wire for the operation of relay M in the first code selector; **TP4** connects the 1,000-ohm coil of relay G to the Z pulse wire. After a period of some 30 seconds, earth is applied to the Z pulse wire and relay G operates to extend earth from $H1$ through **G1** and **TP2** to the forced release wire (vii) for the operation of relay M

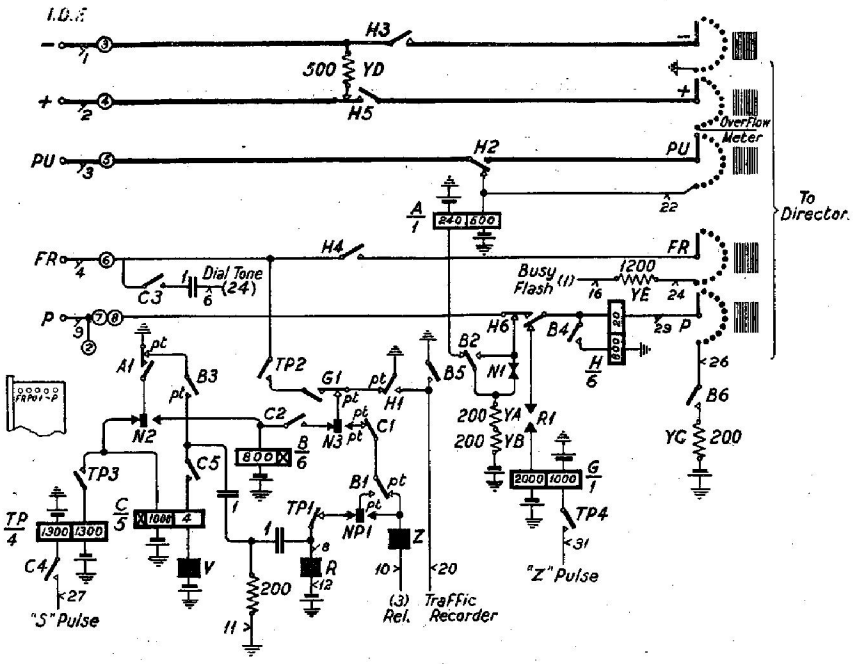


FIG. 205. A-DIGIT SELECTOR

which effects the release of the A-digit selector in the manner described on page 313.

Vertical Movement. Relay A is impulsed by the earth pulses repeated over the pulse wire by relay L in the first code selector. Contact $A1$ closes and opens the vertical magnet circuit and, the wipers are raised to the level required, the vertical off-normal springs changing-over at the first vertical step (ii). On the completion of the impulse train, relay C releases and $C1$ closes the circuit of the rotary magnet which operates from earth, $H1$, $G1$, **N3**, $C1$, **B1**, $NP1$ and $TP1$. The wipers enter the level and relay G is extended through **R1** to the P-wire of the first outlet. If the outlet is engaged, relay G operates and

G1 disconnects the rotary magnet circuit (iii); relay *H* does not receive sufficient current in these conditions to cause its operation. A free outlet is indicated by a battery through 500 ohms connected to the *P*-wire and, when the wipers step to the bank contacts of a free outlet, relay *G* is unable to operate, and relay *H* operates from the battery connected to

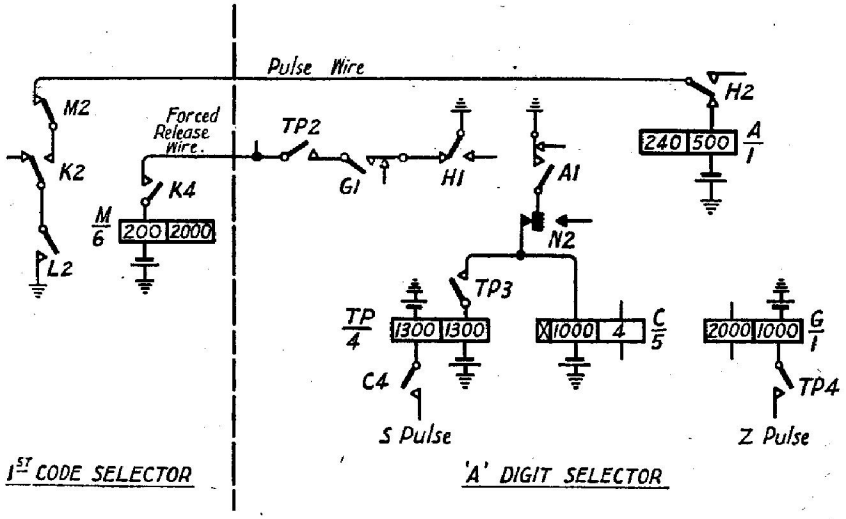


FIG. 206. FORCED RELEASE FROM A-DIGIT SELECTOR

the *P*-wire; **H1** closes a circuit for the retention of the traffic recorder indicating magnet, which registers the duration of the time for which the *A*-digit selector is in use, and is first closed by the operation of relay *B* on the seizure of the *A*-digit selector; the remaining contacts of relay *H* switch the negative, positive, pulse, forced release, and *P*-wires through to the first code selector, relay *H* remaining operated on its 20-ohm coil from the battery connected to the *P*-wire in the director (v), (vi).

Release from First Level. As no code letters are allotted to a single impulse, it follows that one impulse cannot be received as a legitimate *A*-digit. A single impulse may, however, be received should the subscriber dial incorrectly, or should he fumble in removing the receiver. Hence, the *A*-digit selector is arranged to restore should it be stepped to level one. The normal post springs are fitted to the shaft and are arranged to operate when the selector rises to the first level. Should a

single impulse be received, the release of relay *C* when the impulse is completed closes the circuit of the release magnet through **NP1,** and the selector restores to normal (viii). In effect, therefore, the selector absorbs digit 1.

All Outlets Engaged (Fig. 207). Should all the outlets be engaged, the wipers are stepped to the eleventh contact and

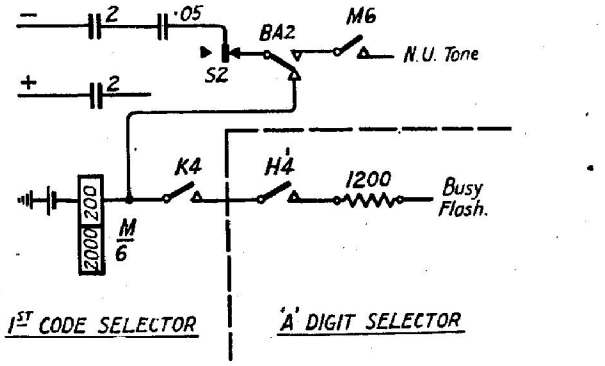


FIG. 207. BUSY CONDITION, A-DIGIT SELECTOR

relay *H* is operated by the battery connected to the eleventh *P* bank contact of the level. Relay *A* is extended over the eleventh bank contacts of the pulse wire and **H2,** to provide for its retention during the busy back condition. Busy flash is connected to the forced release wire and returned to the calling subscriber *via* *I*1, *B* *A*2, and *S*2 in the first code selector: relay *M* does not operate. When the caller clears, the first code selector and the *A*-digit selector are released (iv).

Release. The *A*-digit selector is released by the removal of battery from the *P*-wire in the director. Relay *H* releases and closes the release magnet circuit at *H*1, relays *A* and *B* having been released when the circuit is switched through on the seizure of a free outlet (ix).

The Director. The director consists of two portions, the *BC*-digit selector and translation field, and the relays and six uniselectors. A photograph of the two portions comprising a director is given in Fig. 208. The *BC*-digit selector is a two-motion selector mechanism having six wipers and six 100-contact banks; this selector responds to the *B* and *C* digits dialled by the calling subscriber. The bank contacts of the *BC*-digit selector are wired out to terminals on the translation field. When the selector is stepped to any position,

therefore, the six wipers are extended to six tags on the translation field. The six uniselectors mounted on the other portion of the director are the thousands, hundreds, tens and

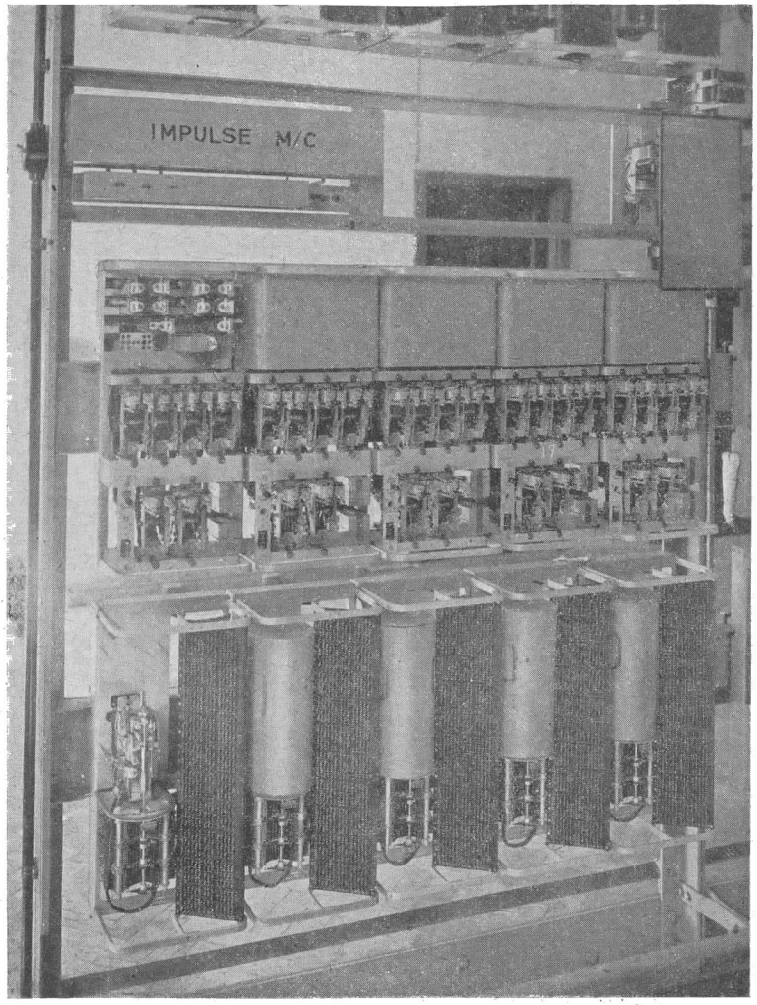


FIG. 208. PORTION OF SHELF, SHOWING FIVE DIRECTORS

units registers, which are stepped by the thousands, hundreds, tens, and units digits of the number dialled by the calling subscriber; the units register is also used as a digit distributor,

so obviating the need for a separate switch: the remaining two uniselectors are the sender and control uniselectors respectively. The sender uniselector counts the number of impulses sent out over the pulsing-out wires and, when the required number has been sent, short-circuits the pulsing-out loop. The control uniselector is operated after each train of impulses

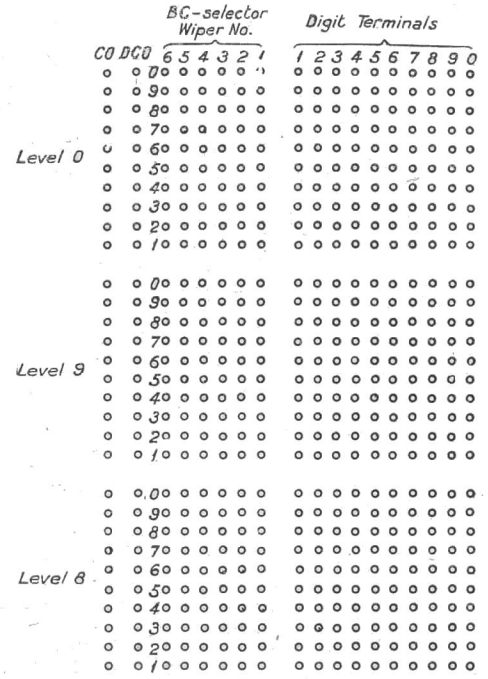


FIG. 209. PORTION OF TRANSLATION FIELD

has been sent out, and its function is to mark in turn the six wipers of the *BC*-digit selector and the arcs of the digit registers. The control relays are mounted under a dust cover on the same portion as the six uniselectors, and comprise ten relays. Where a director is required to serve for routing calls to the auto-manual switchboard from the 0 level of the *A*-digit selectors, an *MB* relay is added and is fitted on the mounting plate of the *BC*-digit selector.

The *BC*-digit selector is stepped vertically under the control of the *B*-digit dialled and in a rotary direction under the control of the *C*-digit. The wipers of the *BC*-digit selector

can, therefore, be stepped to any one of 81 positions, the absence of code letters for digit 1 resulting in 9 out of the 10 levels being reached by the selector and 9 contacts in each level being available. Thus, there are 81 possible positions to which the wipers may be stepped, and these 81 connexions are extended to the tags on the translation field. The appearance of a portion of the translation field is illustrated in Fig. 209. It will be seen that all the bank contacts are wired out to tags in such a manner that the 6 tags representing any one of the 100 positions of the selector are in a horizontal line. The rows of tags marked 1–0 are commoned vertically and connected to the $S4$ arc of the sender uniselector. The row of tags marked *DCO* is used to mark the end of the train of

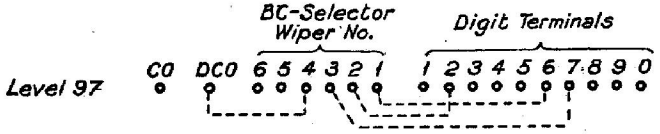


Fig. 210. Cross-connexions on Translation Field

digits comprising the translation, and cause the director to commence sending out the numerical digits forthwith.

The method of setting up a translation by cross-connexion of a translation field is illustrated in Fig. 210, in which it is assumed that wipers 1, 2, and 3 of the *BC*-digit selector are required to provide for translation of the three-letter code into a group of three impulse trains (627). The remaining three trains of impulses which the director could pulse out are cancelled by connecting wiper 4 tag to the *DCO* terminal.

In the case of "code only" calls, that is, calls to TRU, DIR, etc., the translation is set up as described, but the first wiper tag not required by the translation is connected to the *CO* tag to cause the operation of relay *CO* and release the director.

The facilities provided by the director are as follows—

(i) Starts the impulse machine.

(ii) Prepares the circuit for the operation of the *BC*-digit selector which will step vertically under the control of the second code train of impulses.

(iii) Steps the digit distributor (the units digit register) to the next position and prepares a circuit for the rotary magnet of the *BC*-digit selector, which will rotate under the control of the third code train of impulses.

(iv) Steps the digit distributor after each train of impulses and provides a circuit in turn for the thousands, hundreds, tens, and units registers.

(v) Transmits the required number of outgoing impulse trains for routing the call, after the code trains have been received.

(vi) Transmits the numerical trains of impulses.

(vii) Releases when the last numerical train has been sent out, restoring all selectors to their home position.

(viii) Operates the director traffic meter.

(ix) Disconnects the motor start circuit.

(x) Provides a release failure alarm.

(xi) Transmits a forced release condition to the first code selector should the subscriber dial a spare code.

(xii) Transmits a forced release condition over the forced release wire, should the director be held for a period of between 30 and 60 seconds.

(xiii) Transmits a forced release condition should the subscriber clear down before the coder finder has found a free coder on a call to a C.C.I. exchange.

(xiv) Transmits a forced release condition if the $S4$ wiper fails to pick up earth from the *BC*-digit selector.

(xv) Transmits the necessary trains of impulses for routing the call to the auto-manual switchboard as soon as the director is seized from the 0 level of an *A*-digit selector.

(xvi) For code only calls, transmits the necessary trains of impulses for routing the call as soon as the code has been received, and then releases.

The connexions of the director are shown in Fig. 211. A code is used for the various contact arcs of the uni-selector; the control switch levels are marked $CN1$, $CN2$, etc.; the sender switch levels are marked $S1$, $S2$, etc.; the register levels are marked with M, C, D, and U respectively, to denote the rank of the particular digit stored by the selector. All uniselectors are of the 25-point type and are designed for heavy duty.

The diagram in Fig. 211 shows the connexions of the director providing facilities for dealing with 0 level traffic; this function

is performed by relays *D* and *MB* in the manner to be described later. In directors not provided with this facility, relay *MB* is omitted, but in other respects the circuit is precisely the same.

Pulsing-in (Fig. 212). When the director is seized from the level of an *A*-digit selector, the earth connected to the *P*-wire

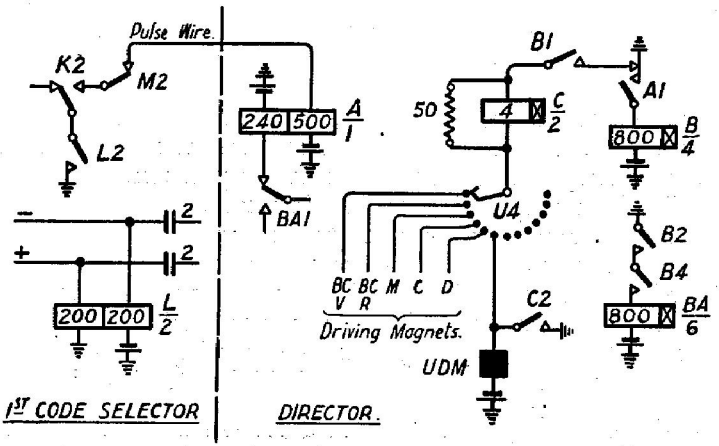
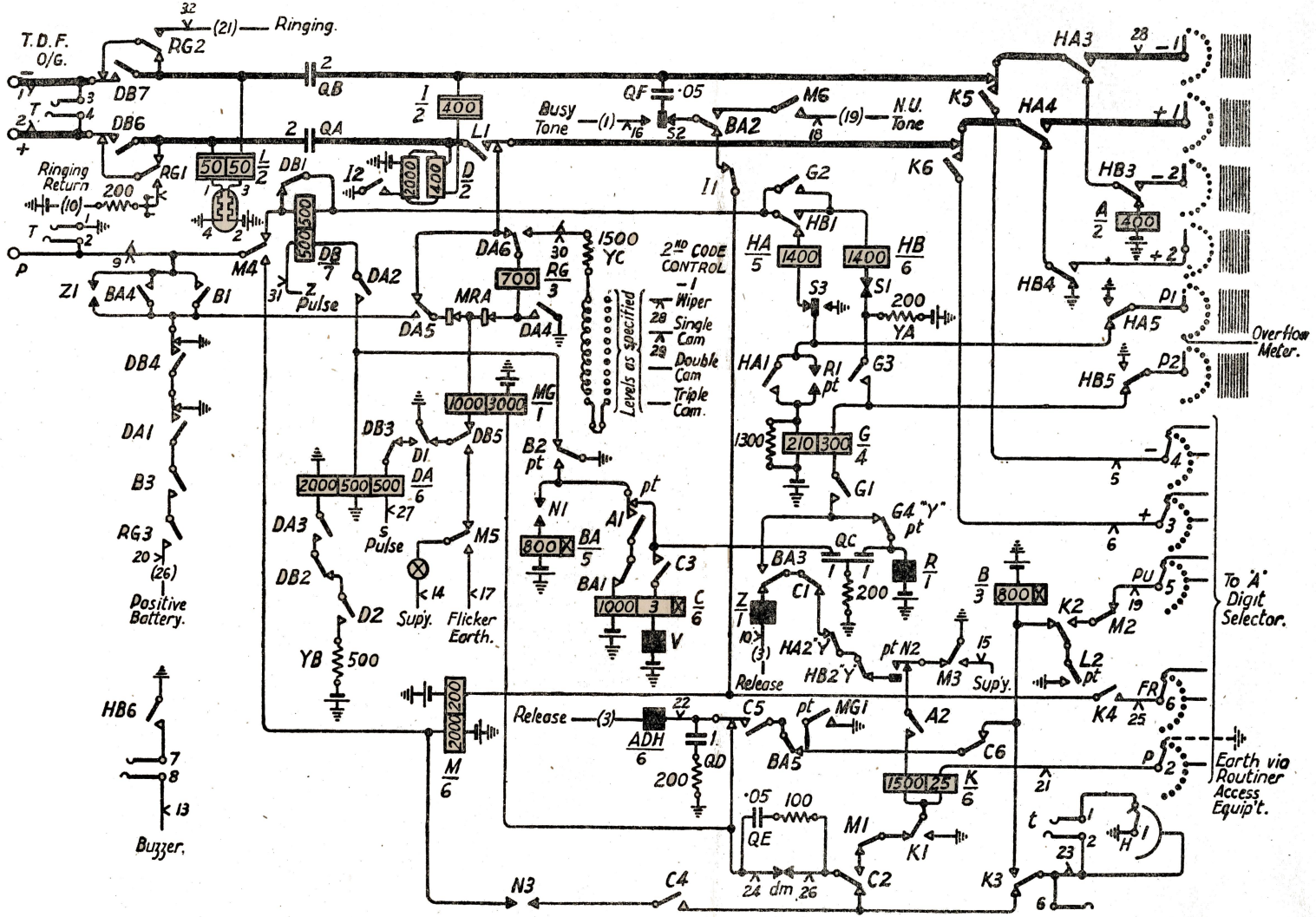


FIG. 212. PULSING-IN

operates relay *A* through *CO*1, *N*1, *M*2, *C*1, and *BA*1. At a later stage, the *A* relay is held by the earth on the pulse wire, through contact **L2** in the first code selector. The operation of relay *A* closes the circuit of relay *B* at **A1**; **B1** prepares a circuit for relay *C*, and the impulsing circuit for the selector driving magnets (ii); **B2** connects earth to the earth common of the director; **B3** prepares a circuit for the meter associated with the director; **B4** closes a circuit for relay *BA*, which is a relief relay for relay *B*. **BA1** disconnects the original operating circuit of relay *A* and prepares an alternative circuit for the battery connected to the *P*-wire; **BA2** extends the *S* pulse lead to relay *TP*; **BA3** extends the common earth to *S*3 wiper; **BA4** closes the impulse machine start circuit (i); **BA5** extends the supervisory lamp to the supervisory key and, if this key is operated, the lamp will glow to indicate the seizure of the director; **BA6** disconnects the release circuits of the digit registers, and the *BC*-digit selector.

When the *B*-digit impulse train is received, relay *A* impulses and, with the first release of *A*1, the circuit of relay *C* and



(T.5070) FIG. 202. 200-OUTLET FIRST CODE SELECTOR WITH MULTI-METERING AND BALLAST RESISTANCE IN TRANSMISSION BRIDGE

the vertical magnet is closed through the wipers of *U*4 arc. Relay *C* operates and **C1** disconnects the battery from the *P*-wire (under premature release conditions); **C2** extends earth from *U*3 wiper to the driving magnet of the units register, which, at the present time, is functioning as a digit distributor. On the completion of the first train of impulses, the wipers of the *BC*-digit selector have been raised to the required level, and relay *C* falls away on completion of its slow-release period; *C*2 disconnects the driving magnet of the digit distributor, and the wipers of this uniselector are stepped to the second bank contacts, where the rotary magnet of the *BC*-digit selector is connected (iii). The receipt of the *C*-digit impulse train impulses the rotary magnet, operating relay *C* to provide for the stepping of the digit distributor on completion of the train (iv). In a similar manner, the four numerical impulse trains are received by the driving magnets of the respective registers, and on the completion of the tens digit impulse train, the digit distributor steps to the sixth bank contact, and thereafter drives forward with the receipt of the units digit.

When the units register, in its function as a digit distributor, steps to the third bank contact in readiness for the receipt of the thousands digit, a circuit is closed for the operation of relay *IG* (impulse guard) through *CO*2, *SZ*1, *D*1, *CN*3 wiper and first bank contact, third bank contact and *U*2 wiper, *M*3 to earth through **B2**; the function of this relay is to protect the driving magnet of the sender switch, which is about to function in sending out the translation, against split impulses. Contact **IG1** disconnects the sender driving magnet from *S*1 arc; **IG2** extends the driving magnet through the magnet impulse springs to earth *via CO*2; **IG3** prepares an alternative circuit to that through *D*1.

Pulsing-out (Fig. 213). With the receipt of the *B* and *C* digits, the exchange to which the call is to be routed is determined and the director can now function with regard to the translation. The portion of the circuit concerned with pulsing-out is shown in Fig. 213. The receipt of the complete train of impulses forming the *C*-digit is marked by the units register, in its function as a digit distributor, stepping to the third bank contact in readiness for the receipt of the thousands digit, as already detailed in the preceding paragraph. Relay *IG* is operated during the break period of the magnet interrupter springs, which have a 66 per cent make period, compared with

a 33 per cent make period for the loop interrupter springs; the magnet springs are open when the loop springs are closed, and *vice versa*; thus, should the units register step to the third bank contact at a time when the magnet springs are making, the operation of relay **IG** is delayed until the springs break. The sender switch driving magnet is brought under the control of the magnet springs through **IG2** and, when the sender switch steps to the third bank contact, the loop interrupter springs are

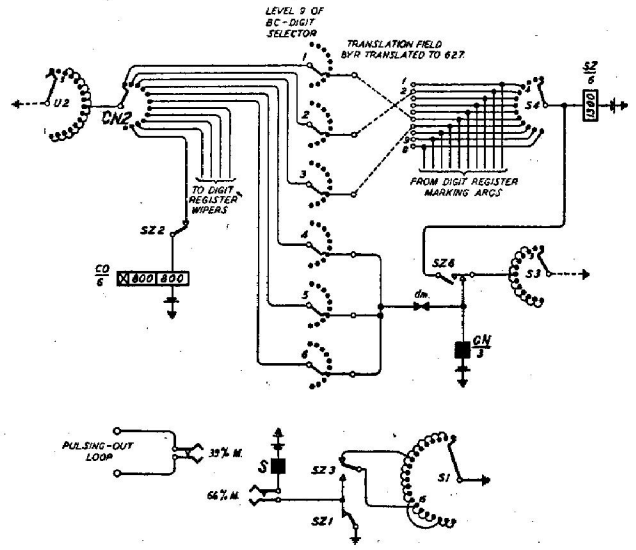


FIG. 213. PULSING-OUT

extended through *M*1 to the negative and positive (that is, the pulsing-out) wires and impulses commence being sent out to operate the *A* relay in the first code selector, and, later, the *A* relays of the remaining selectors in the chain of connexions. For every loop-pulse sent out, the sender switch makes one step, since the loop and magnet springs are associated on the impulse machine. The number of impulses is thereby counted by the sender switch, and when the number required to constitute the train has been sent out, relay *SZ* operates to short-circuit the loop interrupter springs at **SZ4.** The control switch functions to determine the order in which the impulse trains are sent out and the *CN*2

wiper connects earth from the wiper of *U*2 arc and the commoned tags 3–16 first to wiper 1 of the *BC*-digit selector. This wiper is standing upon a particular bank contact as determined by the *B* and *C* digits which have been received, and the tag terminating that bank contact is cross-connected on the translation field to the particular one of the 10 tags constituting the first digit of the translation. In the example shown in Figs. 210 and 213, the translation is assumed to be 627.

When one loop impulse has been sent out, the sender switch steps to the fourth bank contact, and it is this contact which is connected to the digit register bank contacts and the translation field connexion tags corresponding to digit 1; the fifth bank contact is connected to the register bank contacts and translation field tags corresponding to digit 2, and so on. In the case under consideration, when the sender switch steps to the ninth bank contact, six loop impulses have been sent out and a circuit is now closed for the operation of relay *SZ* from earth through *CN*2 wiper, wiper 1 of the *BC*-digit selector, bank contact and terminating tag, cross-connexion wire on the translation field, digit 6 tag, *S*4 wiper to relay *SZ*. The loop interrupter springs are short-circuited at **SZ4,** as already noticed; **SZ1** disconnects the circuit for the sender switch driving magnet and relay *IG*; **SZ2** disconnects relay *CO*; **SZ3** prepares a circuit for returning the sender switch to the 1st bank contact, this circuit being arranged to provide for the inter-digit pause; **SZ5** performs no function at this stage; **SZ6** locks relay *SZ* through *S*3 wiper and **BA3** to earth. Relay *IG* releases and *IG*1 closes a self-drive circuit for the sender switch driving magnet through *S*1 arc and wiper to earth. When the *S*1 wiper steps to the fifteenth bank contact, the self-drive circuit is disconnected and the sender switch driving magnet is brought under the control of the magnet interrupter springs by the operation of relay *IG* in the manner already seen, the relay operating to the earth on *S*1 wiper. The next four steps of the sender switch are therefore taken at intervals of 100 mS, so ensuring that a period of at least 400 mS shall be introduced between the trains of impulses pulsed out by the director. The duration of the self-drive period to bank contact 15 depends, of course, upon the first digit of the translation, and this is the only variable quantity which affects the duration of the inter-digit pause. When *S*1 wiper steps to bank contact 19, relay *IG* is disconnected and the release of the

relay sets up self-drive conditions as already detailed. When *S*1 wiper steps to the first bank contact, the self-drive circuit is disconnected, and the sender switch is ready for the second train of impulses to be pulsed out.

With the operation of relay *SZ*, to mark the completion of a train of impulses, it is possible to step the wipers of the control switch forward to the next bank contacts in readiness for pulsing-out the next impulse train. When *S*3 wiper steps to the third bank contact, a circuit for the driving magnet of the control switch is closed through *SZ*6 and *S*3 wiper to earth. The operation of relay *SZ* disconnects this circuit at **SZ6** and also locks relay *SZ*. Accordingly, the control switch driving magnet is de-energized and the wipers step forward to the next bank contacts.

When the sender switch reaches the home position, relay *SZ* is disconnected and releases; *SZ*1 closes a circuit for relay *IG*, and the next train of impulses is sent out in the manner already described, except that the circuit for relay *SZ* is now *via* the second wiper of the *BC*-digit selector (v).

Digit Cut Off. The first six bank contacts of *CN*2 arc are connected to wipers 1–6 of the *BC*-digit selector to provide for a maximum of six trains of impulses in the translation. Where this number of impulse trains is not required, the bank contacts of those wipers which are not used are connected to the D.C.O. (Digit Cut Off) tag on the translation field. In the case shown in Fig. 213, wipers 4, 5, and 6 are unused, and when *CN*2 wiper steps to the fourth bank contact, the earth is extended through the translation field cross-connexion to the D.C.O. tag and the driving magnet of the control switch. Self-drive conditions are therefore set up and the control switch steps rapidly past bank contacts 4, 5, and 6; contact 7 controls the pulsing-out of the thousands digit and is connected through the thousands register wiper to the particular bank contact reached when the thousands digit was pulsed in previously. The conditions set up for pulsing-out are now similar to those already described, except that the translation field is no longer required, and the operating circuit for relay *SZ* is effected through the permanent wiring between *S*4 arc and the marking arc of the thousands register wiper, and the bank contacts of *CN*2 arc.

Restrained Pulsing-out of Numerical Digits. It has been seen that once the *B* and *C* digits have been received, then the necessary translation is determined and the director pulses this out. For the numerical digits, however, it is necessary to

provide for restraining pulsing-out in the event of a subscriber pausing between digits in dialling the numerical portion; otherwise the director would be liable to catch up with the subscriber and a mutilated impulse train would be sent out in consequence. This is arranged by *CN*3 arc; when the wipers step to the seventh bank contact, the pulsing-out of the thousands digit cannot take place unless the hundreds digit is being or has been pulsed in. The operating circuit for relay *IG*, which controls the sender switch driving magnet, is now taken through *C*2 arc, and the wipers of this switch must be away from their home position before this circuit is closed Similarly, the tens register wipers must be away from their home position before the hundreds digit can be pulsed out, and the tens and units digits are pulsed out when *U*3 wiper is stepped to a contact within the range 7–16. By these means, pulsing-out of a numerical digit is made dependent upon the receipt of the next succeeding digit pulsed in from the subscriber's instrument (vi).

When the units digit has been sent out, the *CN*2 wiper is stepped to the eleventh bank contact and, on the release of relay *SZ* when the sender switch reaches its home position, a circuit is closed through *SZ*2 for the operation of relay *CO*, which effects the release of the director as described later.

"Code Only" Calls. In the event of a call to TRU, DIR, etc., the subscriber dials three code digits only. The translation is set up in the ordinary way on the translation field but the first wiper not required is connected to the *CO* tag on the translation field to provide for the operation of relay *CO* and effect the release of the director (xvi).

0 Level Calls. When a subscriber desires connexion to the auto-manual switchboard, the single digit 0 is dialled. This steps the *A*-digit selector to the tenth level, and a proportion of the directors connected to levels 2–9 of this selector is also teed to the tenth level, but their negative and positive wires are crossed. The director of this type is illustrated in Fig. 208 and, when it is seized from the tenth level of an *A*-digit selector,

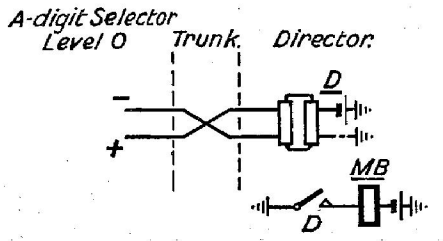


FIG. 214. 0-LEVEL PULSING-OUT CONTROL

it is necessary to set up a translation and commence pulsing-out without the receipt of any further impulse trains. The cross in the negative and positive wires effects operation of relay *D* (Fig. 214); **D3** operates relay *MB*, which connects the rotary magnet of the *BC*-digit selector at **MB1** and locks relay *MB*; since the rotary magnet is in series with 1,300 ohms in these conditions, it remains unoperated. Relay *IG* now operates through **MB2**, since its normal circuit is broken at **D1**; the remaining contacts of relay *MB* set up the translation conditions by connecting the *BC*-digit selector wiper connexions to special tags on the translation field; the standard arrangement provides for a maximum of 3 digits in the translation, but *MB*7 contact is available should an additional one prove necessary (xv).

Calls to C.C.I. Exchanges. It will be seen from Chapter X that for calls between an automatic and a manual exchange in a director area, a considerable amount of auxiliary apparatus is involved in setting up the connexion; in the director or the tandem exchange it is necessary to associate a coder with the circuit to receive the numerical impulse trains pulsed out from the director, and the coder is associated by means of a uniselector hunting over a common group of coders. During periods of congestion, it is possible that the coder hunter may not have connected a coder by the time that the director is ready to pulse out the thousands digit, and in these circumstances it is necessary to restrain pulsing-out until the coder is prepared. On calls to C.C.I. exchanges, therefore, it is arranged that, when the translation has been pulsed-out, the battery and earth connected to the negative and positive wires are reversed by the coder hunter until such time as a coder is ready to receive the numerical impulse trains. This reversal causes the operation of relay *D* and **D1** disconnects the circuit of relay *IG*; **D2** prepares a circuit for the forced release of the selector should the calling subscriber clear during this interval (xiii); **D3** is not concerned at this stage, since the circuit of relay *MB* is disconnected by *U*2 wiper. Pulsing-out is thereby restrained until such time as a coder is found, when the restoration to normal conditions on the negative and positive wires effects the release of relay *D* which re-connects relay *IG* at *D*1; the numerical impulse trains are now pulsed out in the manner already described.

Spare Codes. If the calling subscriber dials a spare code, that is, a combination of letters which has not yet been allotted

to an exchange, it is necessary to release the director to connect N.U. tone to the calling subscriber. This function is performed by *S*5 wiper. On the receipt of the *C* digit of the spare code, the sender switch commences stepping, due to the operation of relay *IG*. Since there is no translation set up on the translation field, however, relay *SZ* remains unoperated, and when *S*5 wiper steps to the fourteenth bank contact, relay *M* is operated from the earth through *SZ*1. This relay locks through **M3**; **M5** retains the circuit of relay *IG*; **M1** disconnects the pulsing-out loop to release relay *A* in the first code selector; **M2** disconnects the *P*-wire to release the *A*-digit selector and the *A*-digit hunter; **M4** prepares a circuit for the forced release wire; **M6** connects earth through **BA3** to the thirteenth bank contact of *S*4 arc. The sender switch continues driving, and when the wipers step round to bank contact 13 again, relay *SZ* is operated by the earth through **M6**; **SZ3** connects earth from **M4** to the forced release wire, with the result that relay *M* in the first code selector is operated to apply forced release conditions, as described on page 313 (xi).

Permanent Impulsing. If, for any reason, such as a disconnected wiper, relay *SZ* fails to operate when the *S*4 wiper steps to the contact marked by *CN*2 wiper, loop impulses will continue to be sent out. This condition is known as permanent impulsing, or, more colloquially, as "permanent Strowger." *S*5 wiper provides for the release of the director in these conditions. Since relay *SZ* is unoperated, relay *M* operates when *S*5 wiper reaches bank contact 14, and forced release is applied in the manner detailed in the preceding paragraph (xiv).

Release of the Director. On the completion of pulsing-out, the director is released by the operation of relay *CO*, either through the eleventh bank contact of *CN*2 wiper or *via* the *CO* tag; **C04** locks the relay to earth through **B2**; **C01** disconnects the *P*-wire to release the *A*-digit selector and to switch the connexion through in the first code selector; **C02** disconnects relay *IG* to prevent the sender switch from stepping again; **C03** connects interrupted earth through the busy key to the supervisory lamp, this signal being utilized to indicate a failure to release; **C05** closes the release alarm circuit; **C06** closes the circuit of the meter associated with the director, so registering the operation (viii). The sender switch wipers are returned to their home position over the self-drive circuit already described, and on reaching the first bank contact, a circuit is prepared for the restoration of the control switch, the digit registers, and

the release of the *BC*-digit selector. Meanwhile, when the connexion is switched through in the first code selector, relay *A* is released and *A*1 disconnects relay *B*, which releases slowly; *B*4 disconnects relay *BA* (ix) and *B*2 disconnects relay *CO*. *BA*6 closes the homing circuit for the control switch and, when the wipers of this switch reach their home position, a self-drive circuit is closed for the units register, the tens register, the hundreds register, and the thousands register in turn. When the thousands register wipers reach their home position, a circuit is closed for the release magnet of the *BC*-digit selector and the restoration of this selector causes the circuit of relay *CO* to be disconnected at *N*3. The release of relay *CO* disconnects the supervisory lamp and release alarm circuits (x), and the director is now ready to receive another call, since battery is connected to the *P*-wire through *CO*1 (vii).

Delayed Dialling. When the director is seized the operation of relay *BA* extends the *S* pulse wire through **BA2** to relay *TP* and, with the first *S* pulse, this relay operates and locks through **TP1**; **TP2** extends the *Z* pulse wire to the second coil of relay *M*. The *Z* pulse is applied some 30 seconds later, and, if the director has not been released in the meantime, relay *M* is operated to effect the forced release of the connexion. The director may, therefore, be held for a period of between 30 and 60 seconds before forced release conditions, due to delayed dialling, are applied. Since the normal holding time of a director is some 18 seconds, this provides ample margin (xii).

Tandem Selector

Tandem Selector with Transmission Bridge. To obviate the need for outgoing junction relay-sets at Tandem exchanges, as was the original practice, each incoming junction is terminated on a selector having a transmission bridge. The connexions of a typical selector of this type are shown in Fig. 215; the circuit follows the orthodox design of a 200-outlet group selector, at the same time incorporating impulse repeating facilities.

When the selector is seized, relay *A* operates and **A1** operates relays *B* and *C*. Receipt of the first train of impulses causes the vertical magnet to be energized and with the first vertical step the vertical off-normal springs are changed over. Relay *C* is now dependent upon the impulsing circuit of the vertical magnet for its retention, and on completion of the vertical

movement, relay *C* releases at the end of its slow-release period. The circuit of the rotary magnet is now closed by **C1** through *G*4"*y*," **B1**, **N1**, *HB*6"*y*" and *HA*6"*y*" to earth. The wipers are moved into the level reached and the rotary off normal springs are changed over. **NR1** prepares for the re-operation of relay *C* under impulse repetition conditions, whilst **NR2** closes the circuit of the polarizing coil of relay *D*.

Relay *G* now functions as the testing relay, and if both of the outlets are engaged, relay *G* operates to disconnect

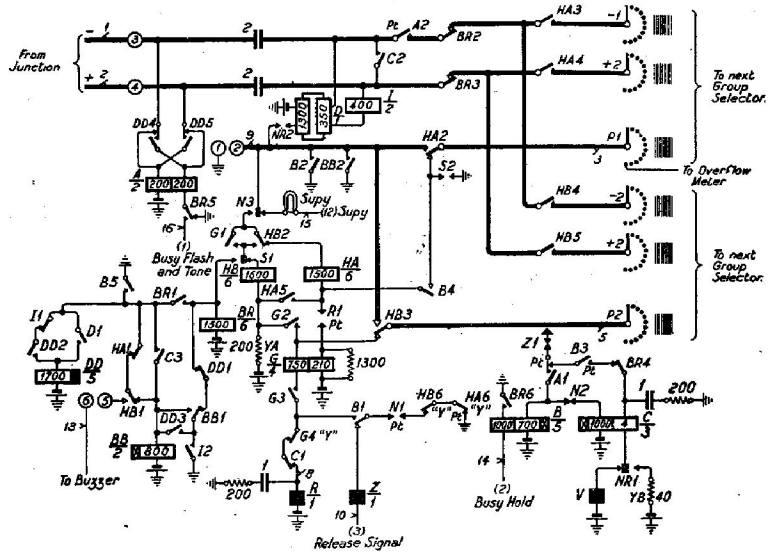


FIG. 215. INCOMING SELECTOR WITH TRANSMISSION BRIDGE

the rotary magnet at **G4"y."** This causes the rotary interrupter springs to break, disconnecting relay *G* and re-operating the rotary magnet. This action recurs until a free outlet is found. When this occurs either relay *HA* or relay *HB* operates to switch the free outlet to relays *D* and *I* through contact **A2.**

When a free outlet has been seized, the remainder of the trains of impulses are repeated to the succeeding selectors by the impulsing of contact *A*2. During each train of impulses, relay *C* is operated through **NR1**, and **C2** short circuits relay *I* and the 350-ohm coil of relay *D* in order to provide a loop of zero resistance for impulsing purposes. On completion of each train of impulses, relay *C* releases after the expiry of its slow-release period, re-connecting relays *D* and *I* to the outgoing line.

When, ultimately, the called subscriber replies, relay *D* is operated by the reversal of current flowing through its 350-ohm coil. The relief relay, *DD*, is operated and repeats the current reversal by **DD4** and **DD5.**

A novel feature of this selector is that, on receipt of busy-back conditions from the objective exchange, whether automatic or manual C.C.I., all forward apparatus is released and busy-back conditions are applied from the tandem selector. Since the circuit so released includes the junction from the tandem exchange and the objective exchange, this facility results in a saving in the number of junctions required.

With the first application of busy-back, relay *I* releases during the flash period and re-operates during the ensuing pause of 0·75 sec. *I*2 releases relay *BB* and when relay *I* re-operates, **I2** completes the circuit of relay *BR* through **I2,** *BB*1, and *DD*1. Relay *BR* locks to earth through **B5** and **BR1**; **BR2** and **BR3** disconnect the loop in the tandem selector that is holding the forward apparatus, so releasing the outgoing junction and all associated equipment; **BR4** disconnects relay *C* and the vertical magnet to prevent interference when relay *A* releases later; **BR5** connects busy tone and flash to the incoming junction; **BR6** closes the busy hold circuit of relay *B*. The busy-back condition is now being given from the tandem selector and all forward apparatus has been released, including the junction to the objective exchange.

CHAPTER IX

INTERCOMMUNICATION BETWEEN AUTOMATIC AND MANUAL EXCHANGES

Introduction. The previous chapters have been devoted to a description of the apparatus components, and the circuits built up from them, which are required in automatic exchanges for the purpose of completing connexions between subscribers on those exchanges. It is necessary now to consider the various methods of providing intercommunication between the subscribers connected to automatic exchanges and those connected to manual exchanges. One of the most common methods of completing calls from a manual exchange to an automatic exchange is to provide the operators at the manual exchange with means of associating a dial with the calling cords used for such calls, and providing apparatus to enable dialled impulses to be transmitted over the junction to the automatic exchange. This method is termed "dialling-in," and the junctions are known as "dialling-in junctions." Similarly, it soon became apparent that automatic operation could be extended to calls from automatic exchanges to nearby manual exchanges by allotting a code to those manual exchanges; when this code is dialled a junction to the manual exchange is seized and the calling signal given. The operator at the manual exchange answers and, after ascertaining the number required, effects the connexion. This method is termed "dialling-out," and the junctions over which such facilities are possible are termed "dialling-out junctions." Where dialling-out facilities are provided, however, special precautions have to be taken to ensure that metering is not effected until the called subscriber at the manual exchange has replied. Further, owing to the rapid release of automatic switching equipment, means have to be taken to prevent the circuit from being seized until the operator has removed the plug; at C.B. exchanges, however, the calling circuit is arranged to accept a following-on call, even though the operator may not have removed the plug used for the preceding call. The circuits providing dialling-in and dialling-out facilities are dealt with on pages 339 and 346 respectively.

The provision of dialling-out codes, however, is only useful for circuits to manual exchanges in the immediate vicinity,