Feb. 10, 1942. B. A. HENSLER 2,272,464

TELEPHONE SYSTEM

Filed Nov. 18, 1939 8 Sheets-Sheet 1

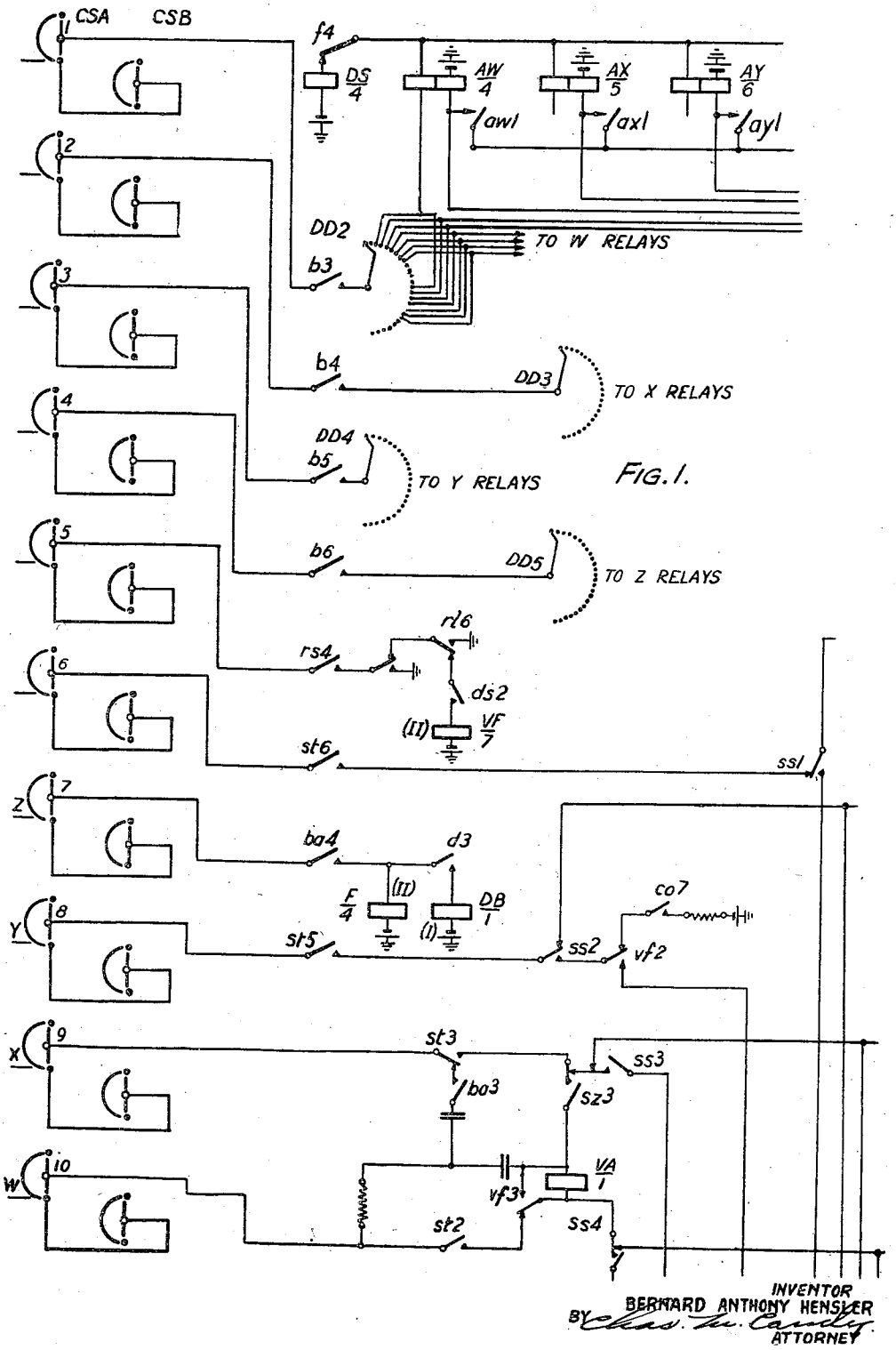



FIG. 1.

Feb. 10, 1942. B. A. HENSLER 2,272,464

TELEPHONE SYSTEM

Filed Nov. 18, 1939 8 Sheets-Sheet 2

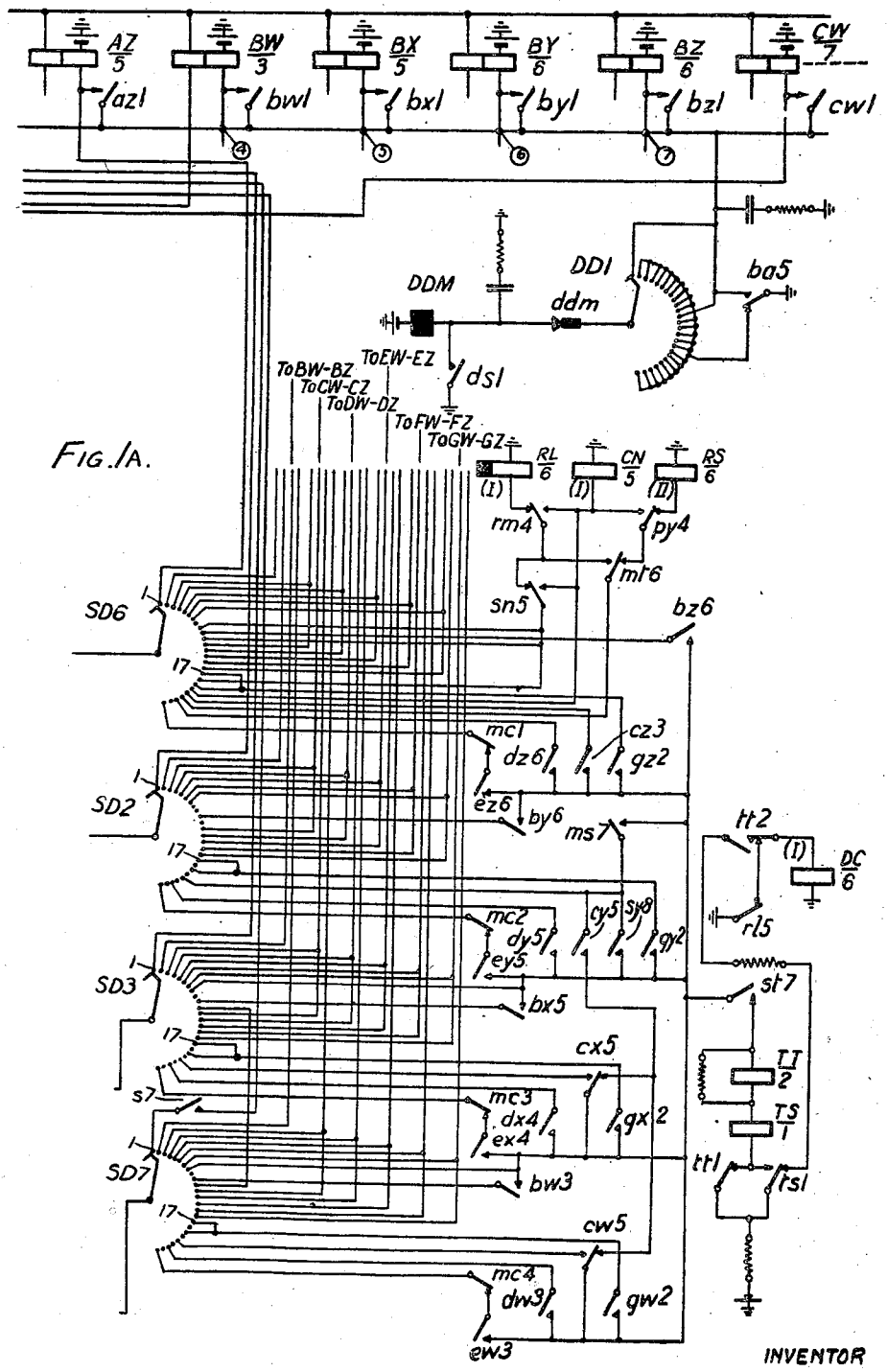



FIG. 1A.

INVENTOR
BERNARD ANTHONY HENSLER
BY Chas. Tu. Candy
ATTORNEY

Feb. 10, 1942. B. A. HENSLER 2,272,464

TELEPHONE SYSTEM

Filed Nov. 18, 1939 8 Sheets-Sheet 3

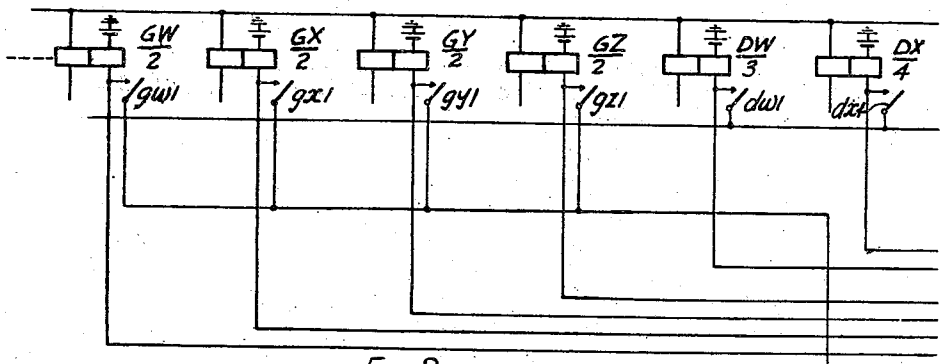
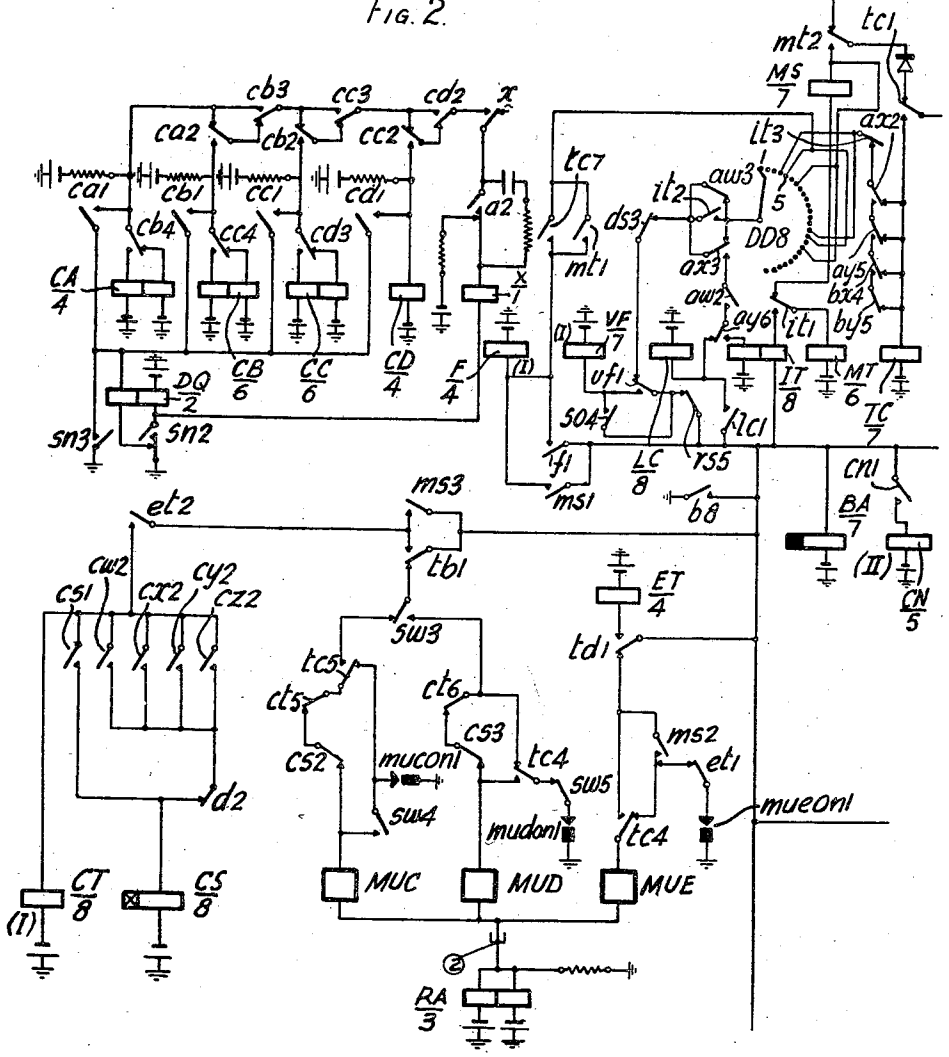



FIG. 2.




INVENTOR
BERNARD ANTHONY HENSLER
BY Chas. M. Candy
ATTORNEY

Feb. 10, 1942. B. A. HENSLER 2,272,464

TELEPHONE SYSTEM

Filed Nov. 18, 1939 8 Sheets-Sheet 4

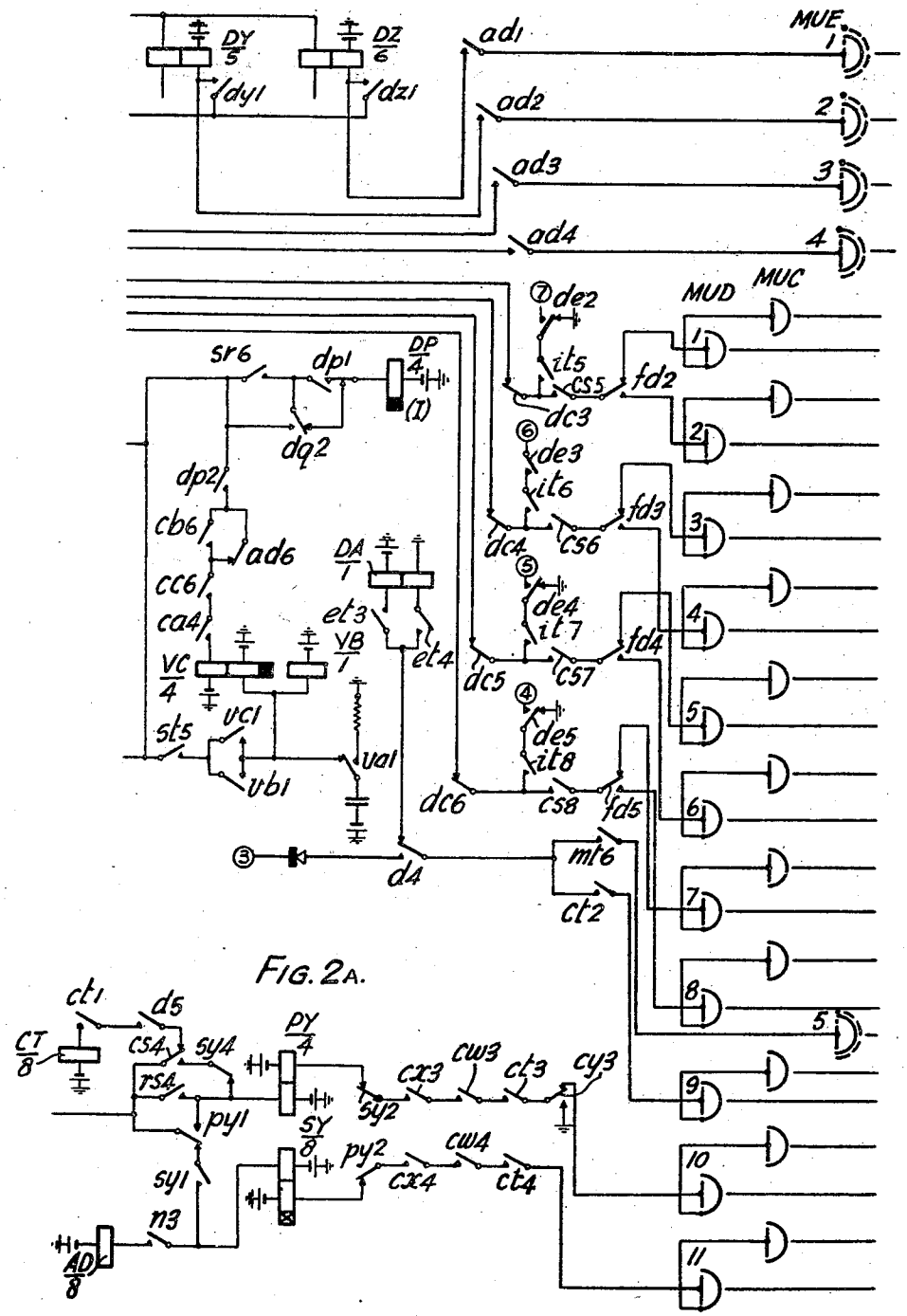



FIG. 2A.

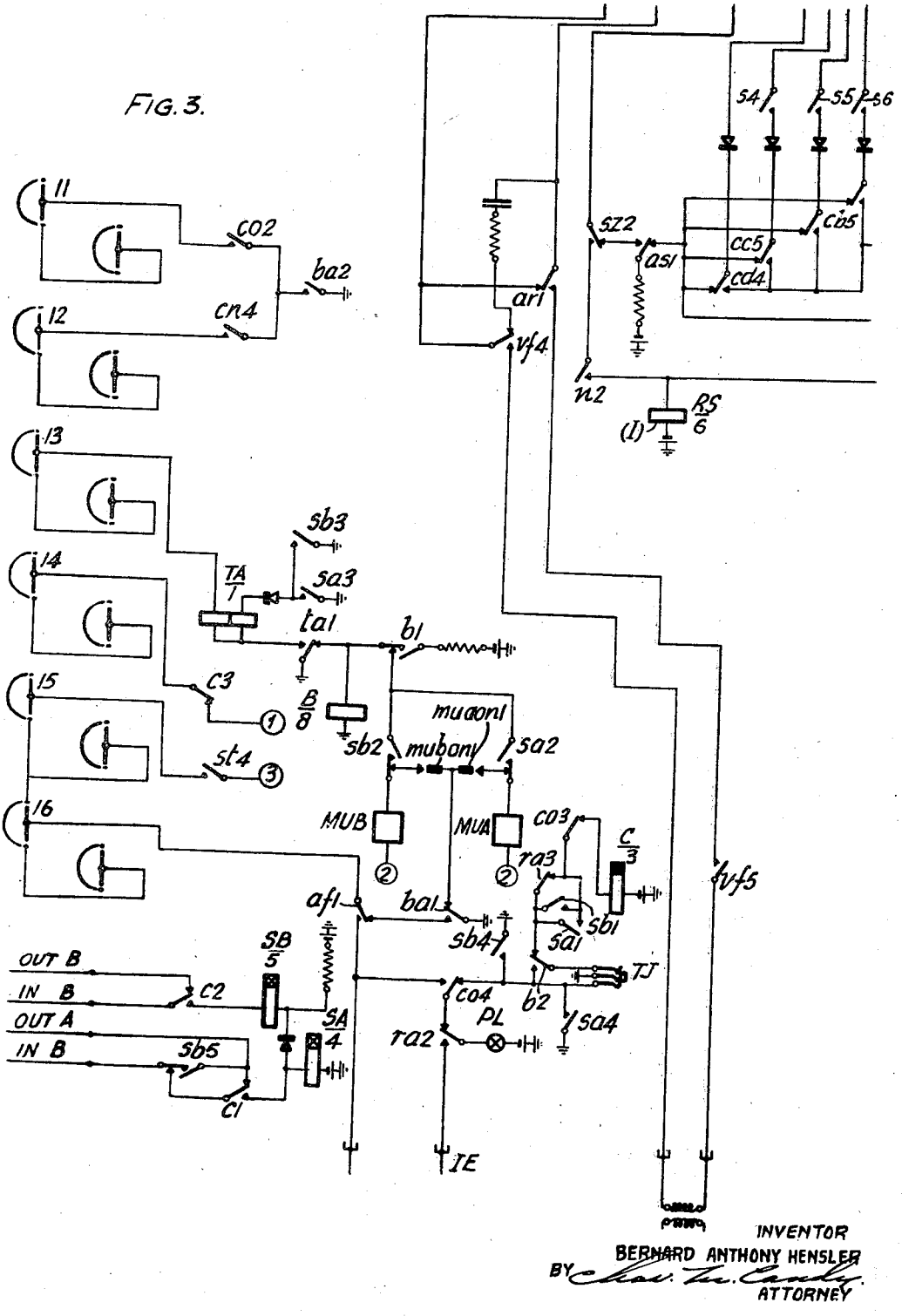
INVENTOR
BERNARD ANTHONY HENSLER
BY Chas. Tu. Candy.
ATTORNEY

Feb. 10, 1942. B. A. HENSLER 2,272,464

TELEPHONE SYSTEM

Filed Nov. 18, 1939 8 Sheets-Sheet 5

FIG. 3.



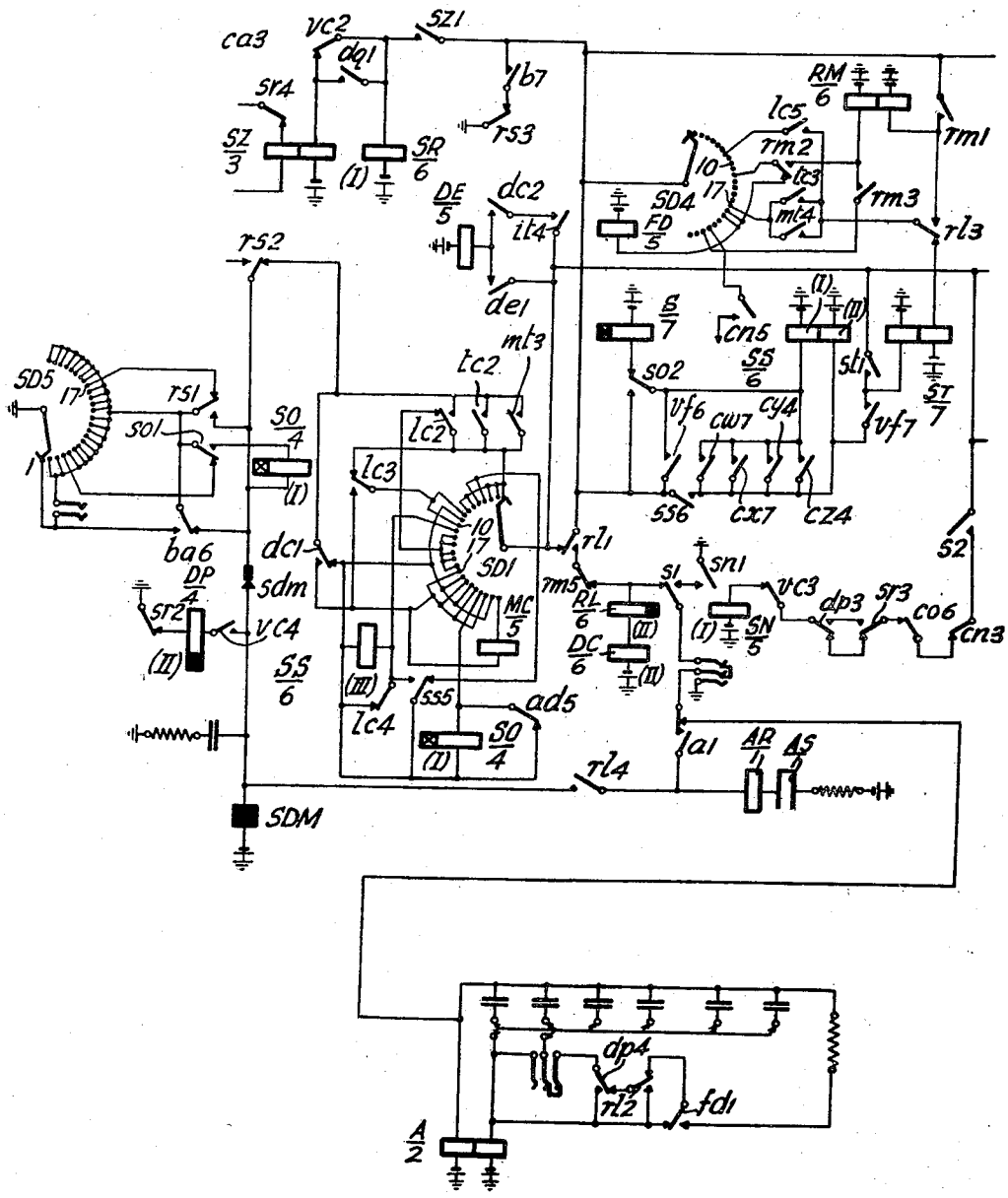

INVENTOR
BERNARD ANTHONY HENSLER
BY Chas. Tu. Cooley.
ATTORNEY

Feb. 10, 1942. B. A. HENSLER 2,272,464

TELEPHONE SYSTEM

Filed Nov. 18, 1939 8 Sheets-Sheet 6

FIG. 3A.



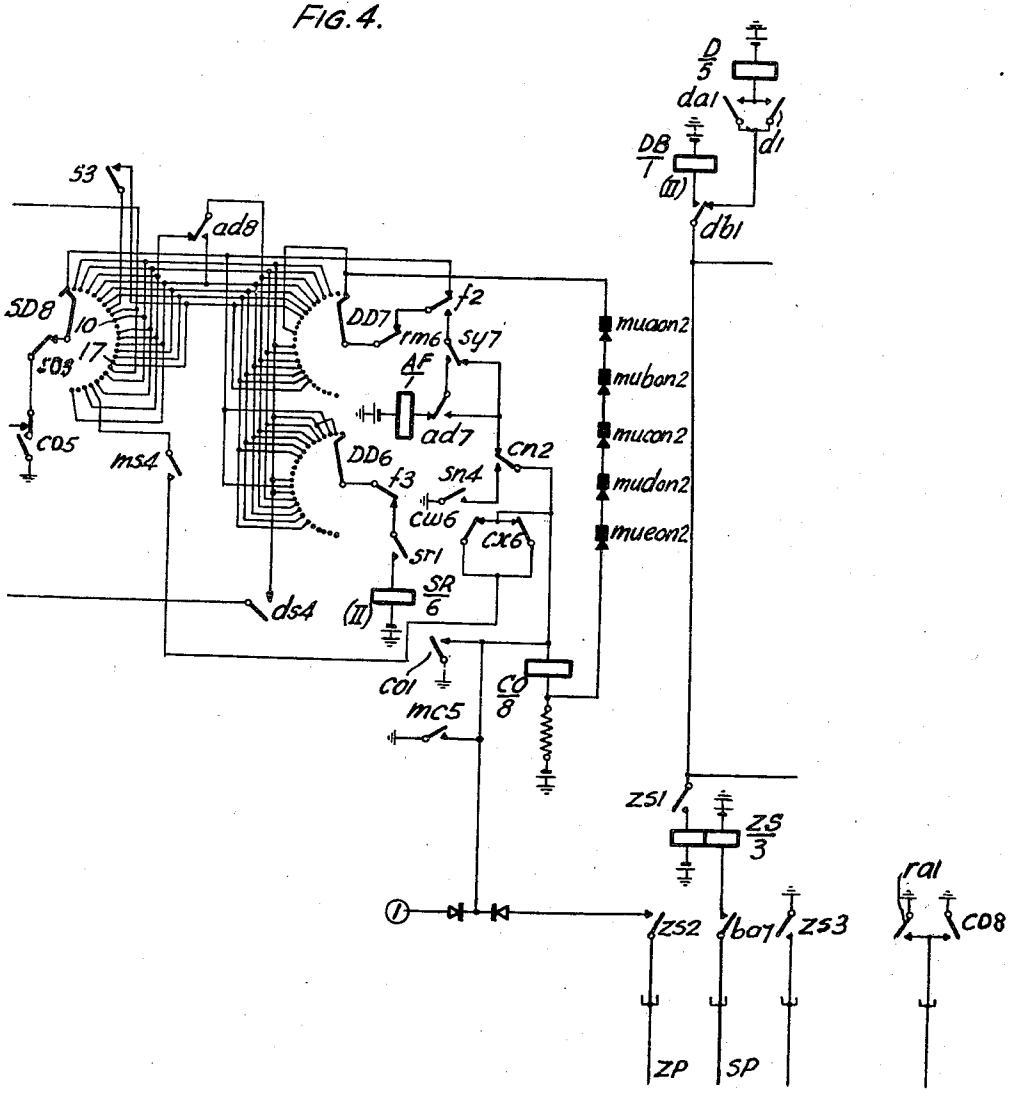

INVENTOR
BERNARD ANTHONY HENSLER
BY Chas. Tue. Candy
ATTORNEY

Feb. 10, 1942. B. A. HENSLER 2,272,464

TELEPHONE SYSTEM

Filed Nov. 18, 1939 8 Sheets-Sheet 7

FIG. 4.




INVENTOR
BERNARD ANTHONY HENSLER
BY Chas. Tu. Candy
ATTORNEY

Feb. 10, 1942. B. A. HENSLER 2,272,464

TELEPHONE SYSTEM

Filed Nov. 18, 1939 8 Sheets-Sheet 8

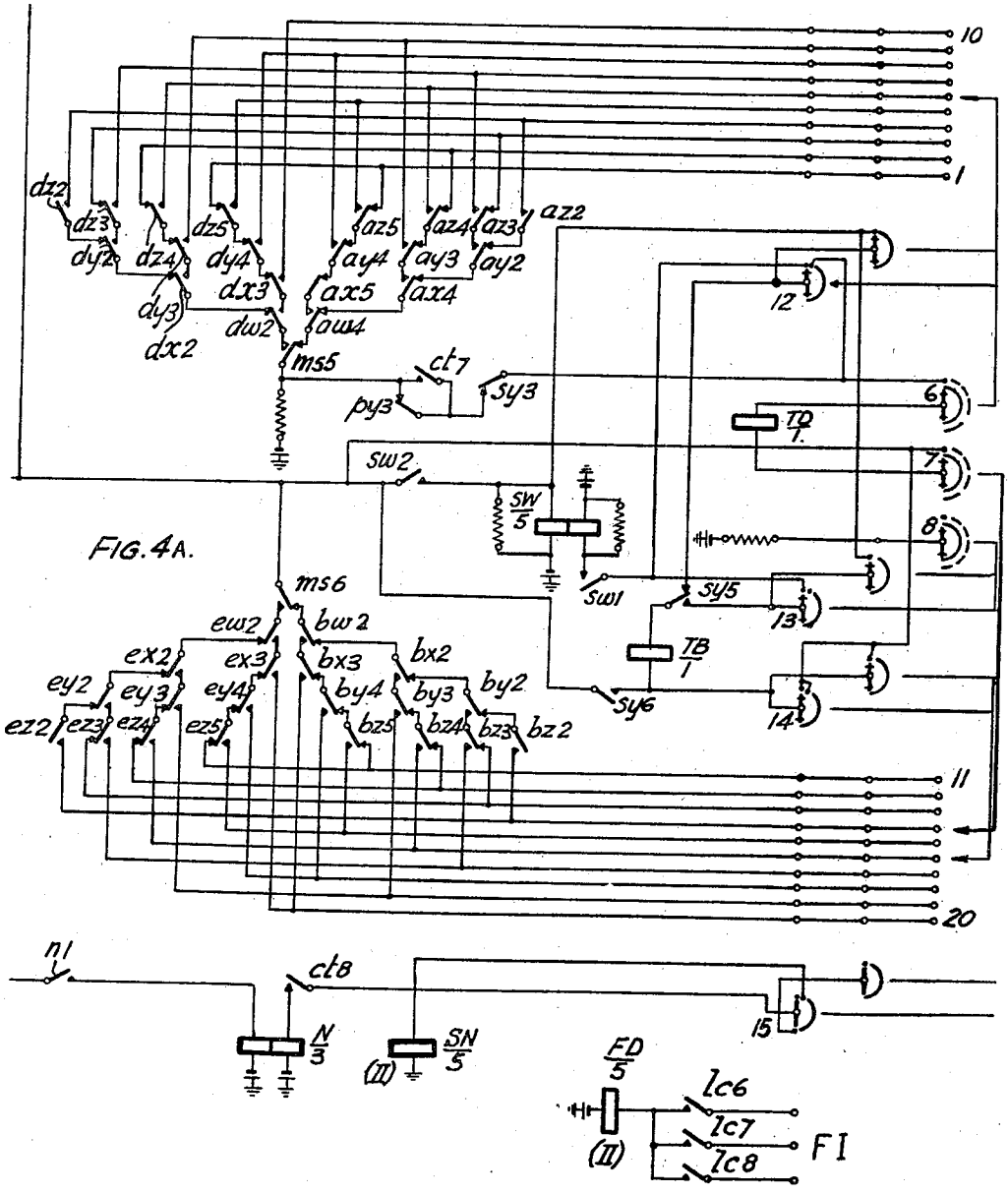



FIG. 4A.

INVENTOR
BERNARD ANTHONY HENSLER
BY Chas. Tu. Candy.
ATTORNEY

Patented Feb. 10, 1942 2,272,464

# UNITED STATES PATENT OFFICE

2,272,464

## TELEPHONE SYSTEM

Bernard Anthony Hensler, South Woodford, London, England, assignor to Siemens Bros. & Company Ltd., a British company

Application November 18, 1939, Serial No. 305,146
In Great Britain November 18, 1938

12 Claims. (Cl. 179—18)

This invention relates to telephone systems and more particularly to systems in which calls between exchanges are set up over automatic switches by operators.

In such systems a register sender is usually employed which registers the digits transmitted to it by the operator, the digits in one form of system being in the form of a code transmitted from a key strip, and transmits digits which may be the same as or different from those received for the setting up of the desired connection. The register sender is usually available in common to a number of operators' positions and may include a number of registers sufficient for the registration of the whole of the number to be transmitted for the setting up of the required connection or arrangements may be employed whereby a less number of registers is required. The digits to be transmitted from the register sender may be either in code form or impulse form. As a rule coded digits would only be used for setting switches in the same or in an adjacent exchange where more than two signalling wires may readily be provided, impulses being used for transmission over junctions and trunks to distant exchanges and to local switches which are available to subscribers and are arranged for the reception of impulses.

In the selection of a route which a call is to take consideration may be given to the state of traffic over the normal route and the sender may embody arrangements whereby if all the direct trunks in the desired direction are engaged an alternative route is selected. These arrangements may embody group control circuits associated with the trunk groups and operating on translating arrangements whereby in response to the transmission to the register sender of digits denoting the trunk required two translations may be made or prepared one for the direct route and the other for an alternative route to be taken if the direct route is congested.

Furthermore in a trunk switching system it may be desirable to transmit impulses over the trunks in the form of impulses of voice frequency alternating current.

In the present invention the register sender is adapted to send out impulses of voice frequency alternating current. At the same time ordinary D. C. impulses may be sent out from the sender so that at all times the type of impulsing may be suited to the selecting arrangements which may be met with. With this dual form of impulsing arrangements may be provided at a suitable circuit, where the nature of the distant selecting arrangements may be determined, whereby the undesired form of impulses is suppressed, only the desired form being allowed to go forward. Arrangements may be provided in the sender itself whereby in some cases the nature of the impulses to be sent can be determined and only impulses of one form are sent out.

The sender may be arranged so that normally impulses to be sent out are D. C. impulses. The sending of voice frequency A. C. impulses may be brought about in response to particular cross connections in the translating field or in response to a signal from the operators' position or a trunk selected or outgoing repeater circuit. It may be convenient in the transmission of voice-frequency A. C. impulses to permit the transmission of D. C. impulses simultaneously these being suppressed at some convenient point.

As regards the digits received by the sender some of these may be translated or be otherwise utilised and others may be re-transmitted unchanged. In the setting up of a trunk connection it may be sufficient in most cases to transmit coded digits in response to a received code for the setting of trunk selectors to select the desired trunk route which may and usually would terminate at a manual trunk position at the distant exchange. The sender may then release itself automatically or be released by the operator. If the trunk or outlet from the trunk selector terminates in an automatic switch over a two wire circuit it will be necessary to transmit impulses for the setting of this switch and possibly succeeding switches.

Accordingly for the same digits received by the sender the sender may be arranged to send out different digits depending on the state of the route indicated by the received digits. Thus in the case of an alternative route through an exchange at which the trunk is terminated on an automatic switch an additional digit may be interpolated for the setting of this automatic switch and the additional digit may be transmitted as a train of A. C. impulses of voice-frequency. In this case if a state of congestion is encountered at the intermediate exchange a voice-frequency signal may be reverted over the trunk and transformed into a D. C. signal to the sender to cause it to dispose of the call in some other manner which may require a different number of digits.

As regards the provision of alternative routes these may in general be the same as direct routes to some other exchanges but the arrangements of the sender provide for groups of trunks

which are not direct routes to any exchange but exist solely as alternative routes if the direct route to which they provide an alternative are busy. The translation effected by the sender for the selection of a solely alternative route may be one in which the digits for the setting of the trunk selectors are digits which cannot be obtained directly by keying by the operator. The operator is generally provided with digit keys on a decimal basis since numerical designations are required to be transmitted but the translated digits may be on a non-decimal basis. To make full use of the availability of the trunk selectors these may be of the uniselector type set by the marking method whereby the number of groups and their size may be provided to suit requirements since the type of switch is not limited to operation on the decimal system. The alternative route trunks referred to are conveniently taken from a special group of trunk selectors and since the translation to reach this group cannot be had at the will of an operator their reservation as an overflow route is assured.

Reference has already been made to arrangements in which the number of registers is less than the number of digits to be sent. It may happen that after an association of the sender with trunk selecting switches and the selection of a desired route a number of digits greater than the number of the remaining registers may be required to be sent or after the sender has been released it may be desired to transmit further digits. In such an event a re-association of the sender with the route already set up may be made and a signal transmitted to the sender as a consequence of such connection to bring about the sending of subsequent impulse trains as trains of voice frequency impulses. At the same time D. C. impulse trains are transmitted so that the form of impulses may suit the selecting arrangements provided. The form of impulses not required may be suppressed or ignored at a suitable point.

The sender may also be provided with arrangements whereby the probable period of delay, if any on a trunk route may be signalled to the operator.

The nature of the invention and the means for carrying it into effect will be better appreciated from a consideration of the following detailed description taken in conjunction with the annexed drawings. These relate to a specific embodiment of the invention and are given by way of example. The drawings, comprising Figs. 1, 1*a*, 2, 2*a*, 3, 3*a*, 4, 4*a* show circuits of a register sender which is adapted to receive keyed up digits in code form and to transmit digits in code form or as impulses for the setting of selecting switches. The sender is of a kind for use at a trunk exchange and means are provided whereby impulses may be transmitted as D. C. leg impulses or as voice frequency impulses or both. The arrangements also provide for suitable translations of some or all of the received digits to be made and for the selection of an alternative route if the direct routes in the direction of the wanted subscriber's exchange are all busy. The sender is adapted to deal with different types of trunk calls and local calls.

The principal parts of the sender are the coupling switches CSA and CSB for connecting the sender to an operator's position for the purpose of setting up a call, register relays comprising 7 sets of 4 relays each, the sets being designated AW, AX, AY, AZ, BW—BZ, and so on to GW—GZ. To avoid overcrowding the drawing relays CX to CZ and EX to FZ have been omitted but these relays are similar to the other register relays shown, their operating windings being connected to contacts in the banks DD2, DD3, DD4 and DD5 of a digit distributor and their locking windings being connected to contact *ba*5 of relay BA in a similar manner to that shown for the registering relays AW—AZ and so on. A digit distributor comprising a pawl and ratchet driven stepping switch with 8 banks of contacts designated DD1—DD8, and stepping magnet DDM provides for the routing of successive digits to the several registers in turn, the switch being controlled for this purpose by relay DS which is connected in series with the several parallel connected-operating windings of the register relays. A controller comprising a pawl and ratchet driven stepping switch with 8 wipers designated SD1—SD8 and stepping magnet SDM provides for the connection of the several registers in turn to the out-sending wires, W, X, Y, Z or to an impulse counter. It also provides connection to relays RL, RS and CN to determine whether re-search or re-routing is required.

There are three latch-controlled motor-driven translating switches the motors of which are represented by their latch magnets MUC, MUD, and MUE respectively. The first two of these switches have each 15 wipers and 50 point contact banks and switch MUE has 8 wipers and 100 point contact banks. Switches MUC and MUD are the main translating switches and their banks are cross connected as follows. Terminals 1 to 9 marked by contacts of the relays of the A and D registers are connected each to a maximum 10 contacts in the banks of wipers 12 of either or both switches. These switch contacts need not be consecutive but may be so chosen that if the switch has to drive from marked contacts to other marked contacts for the purpose of effecting a translation for an alternative route, the search for the new marking may be a short one. If the two routes are alternative to one another this latter provision cannot well be made. Similiarly terminals 11 to 20 marked by contacts of the relays of the B and E registers are each connected to a maximum of 10 contacts in the banks of wipers 14 of one or both of the switches but care must be taken that the several contacts connected to a terminal of the series 11 to 20 appear only once in the corresponding positions in the banks of wipers 12. As the registration of the numeral "0" as a first digit or the registration of the numeral "9" as the first and second digits does not cause the switches MUC and MUD to leave normal only 89 contacts will be taken up by the above mentioned cross connections to the banks of wipers 12. The terminals are cross connected in a similar fashion to contacts in the banks of wipers 6 and 7 of switch MUE and considering the bank associated with each of these wipers as the equivalent of the corresponding banks of the switches MUC and MUD the terminals may be connected to switch MUE in positions corresponding to those to which they are connected in switches MUC and MUD. The switches MUC and MUD are not used on minor trunk calls whereas switch MUE is used on such calls. Accordingly positions on switch MUE used for minor trunk calls may correspond to unconnected positions on switches MUC and MUD Terminals corresponding to the numbers of minor trunks, that is the 4th and 5th digits as will hereinafter appear are cross connected to any

available positions on switch MUE. Terminals of numbers in the "0" group and the number "99" are also cross connected to any available position on switch MUE.

Besides its use on minor trunk calls switch MUE is mainly concerned with alternative routing. The switch is set normally in accordance with the digits indicative of a direct trunk group and cross connections are made between contacts in the bank of wiper 8 of the switch MUE and contacts in the banks of wiper 13 of switch MUC or MUD. Normally the alternative route for one group of trunks will be the direct route for another group of trunks. Arrangements may however be provided wherein a route may be provided with a group of alternative route trunks which are not direct trunks for any other group even though the trunk selectors are fully occupied by direct route and special trunks are connected in a special group of 2nd trunk selectors. As the number of contacts on switches MUC and MUD devoted to direct routes is limited to 89 and the first contacts are used for another purpose there remains 10 contacts available for cross connection to switch MUE for these special alternative route trunks. It will be obvious from this that switches MUC and MUD cannot be set to these positions by depression of the decimal keys in the operator's digit strip but can only reach these positions by reason of the marking applied over the wipers of switch MUE. The translating switches have a combined capacity of 100 outlets and of these one is required for their tandem connection, leaving 99 available outlets. As 89 outlets are required for translating purposes in response to digit key operation there remains 10 outlets available for the special alternative route trunks. The 1st trunk selector must be capable of accommodating at least 12 groups of outlets so that a uniselector for this purpose is imperative if complicated arrangements are to be avoided. Moreover decimal setting is also inadmissable. It will be clear therefore that no combination of digits to be had by decimal key operation will effect the setting of the translating switches to these 10 special positions and that the trunks which are selected corresponding to these positions cannot be reached at will by an operator.

In the banks of the translating switches not previously referred to those in the banks of wipers 1 to 8 of switches MUC and MUD are connected to earthed terminals, the contacts so connected being those which will provide the required translation. The translation for the first digit to be transmitted is made over the odd numbered wipers and that for the second digit over the even numbered wipers. Contacts in the banks of wipers 1 to 4 of switch MUE are also connected to earthed terminals as required to provide a marking to determine the number of voice frequency impulses that are to be counted for the setting of an automatic selecting switch in an intermediate exchange in an alternative route. The contacts in the banks of wipers 9 of switches MUC and MUD are connected to arrangements for signalling the period of delay likely to be experienced in main trunk calls and contacts in the bank of wiper 5 of switch MUE are similarly connected for minor trunk calls. Contacts in the banks of wipers 10 and 11 of switches MUC and MUD are connected to contacts of group control relays for the direct and alternative trunk routes respectively. Contacts in the banks of wipers 15 of switches MUC and MUD are likewise connected to earthed terminals, the contacts being those in positions corresponding to trunk groups for which alternative routes are available, such alternative routes requiring the transmission of a train of voice frequency impulses for the completion of the connection to the wanted exchange.

There are no connections to switches MUC and MUD on dead numbers.

The normal contacts in the banks of wipers 1, 3, 5, 7 of switch MUC are cross connected in a manner which will cause the setting of a 2nd trunk selector to an outlet to a 3rd trunk selector on minor trunk calls.

The impulse counting device comprises the relays CA, CB, CC, CD and X and the impulse generating relay A. By means of cross connections between terminals 11 to 20 and terminals FI relay FD can be operated on some digits to vary the capacity connected in the circuit of relay A for the purpose of increasing the speed of impulsing. The impulse generating and counting device is substantially similar to that described in British Patent Specification No. 471,987. AR and AS are impulse repeating relays.

Of the relays shown PY and SY are concerned with translations for the direct and alternative routes in a desired direction and VF, N and AD are concerned with the transmission of voice-frequency switch setting impulses. Relays TC, IT, MT, MS and LC are concerned with the different types of call that may be set up, relays S, SN, SO, SS, ST, SZ and SR are concerned with impulse transmission and relays VA, VB, and VC are concerned with determination of the intertrain pause. The purpose and function of the other relays will be clear from the detailed description which follows.

The trunk exchange includes three ranks of trunk selectors over two or three of which all outgoing calls are set up. For calls over main trunks and special trunks two ranks of selectors suffice but minor trunks and local selectors are connected to 3rd trunk selectors. The 2nd trunk selectors are set by two digits, the first determining the group of trunks over which a connection is required, the second determining whether the whole group shall be searched or an individual trunk selected. The 2nd trunk selector is provided with outlets to storage equipment for storing calls that cannot be completed immediately but if the selector is employed in a connection which is to take an alternative route the second digit is modified to prevent the selector routing the call to an outlet to a storage position and to bring the selector to rest in a position in which a signal may be returned to the register sender to cause it to re-route the call over the direct route so that it is stored in the storage equipment appropriate to the direct route.

The different types of connections that can be set up and their characteristic features will now be set out.

(1) *Main trunk calls.*—These are calls over the main groups of trunks to distant exchanges. These trunks are reached by the operator keying up three digits, the third of which is "0." The numeral "0" for the first and second digits is excluded as is the combination "99". The third digit "0" (code WX) is used to indicate to the 2nd trunk selector that a trunk group is to be

searched. The first two digits are translated but the third digit is sent out untranslated. If the call is routed by the sender to an alternative route the digit "0" is not transmited but a special digit (code WXY) is transmitted to prevent the call being stored if by the time the storage position on the trunk selector is reached the last available trunk has been already taken into use. If the exchange to which a trunk becomes connected in a call via an alternative route is one in which the switching is automatic the sender will interpolate a train of voice frequency impulses for setting switches in the exchange in the alternative route for advancing the connection to an exchange in the direct route. A call may be routed to a particular trunk in a group by keying one of the digits 1 to 9 as the third digit.

(2) *Minor trunk calls.*—These trunks are trunks associated with routes of lesser importance and are connected in the bank of 3rd trunk selectors. To reach one of these trunks five digits are keyed up, the first three being "990" which select a free outlet to a 3rd trunk selector. The 4th and 5th digits take effect at the 3rd trunk selector to select the desired trunk or one in a desired group.

*Trunk calls requiring the keying of additional digits*

The sender when first taken into use associated itself with a free 1st trunk selector and a trunk route is set up in response to keyed up digits and the sender thereupon releases. If the operator now has to send further digits she takes a sender into use and this can associate itself with the same 1st trunk selector even though it is busy and in consequence of this association with a busy selector impulses sent out are voice frequency impulses. Up to seven trains of such impulses can be sent out.

(3) *Special trunk calls.*—Calls between certain important centres are set up over a special group of trunks. To set up such a connection a special key is operated the code (WXY) of which is translated into a code WXZ not provided by the decimal keys. The second digit selects the trunk group and the third digit would normally be "0" to initiate a search in the selected trunk group. Individual trunks may be selected by keying up a third digit other than "0."

(4) *Local calls.*—These may be from 2 to 7 calls consisting of from 2 to 7 digits, the first digit being "0." The first two digits are translated and re-transmitted in code form to set the 1st trunk selector and the first local selector, subsequent digits being transmitted as impulses.

The means by which calls of the several types referred to may be set up and the arrangements for alternative routing, re-searching and signalling the period of delay to which a call is likely to be subjected will be clear from the detailed description that will now be given. In the drawing points indicated by like numerals in circles are to be taken as being joined together.

The coupling switches CSA and CSB are latch-controlled motor-driven switches having 16 wipers each, each wiper being associated with a 50 point bank. Thus, the sender may connect itself to any one of 100 operator's positions. The switch motors are represented by their latch magnets designated MUA and MUB.

The senders are connected to a chain start circuit. There are actually two such circuits one for positions connected to switch CSA and the other for positions connected to switch CSB, relays SA and SB being the starting relays for the corresponding coupling switches. Relay C is normally operated in a circuit extending over contacts *ra*3 and *b*2, upper springs of the test jack TJ to earth. The chain start circuit is extended over contacts *c*1 and *c*2 to relays SA and SB respectively. Since the functions performed by these two relays are similar it will be assumed for the sake of example that a demand for a sender is received from a position connected to switch CSB. Such a demand is made by an operator pressing a key earthing the wire marked In "B." Relay SB thereupon operates and at contact *sb*1 closes a circuit for relay C independently of contact *ra*3, at contact *sb*2 connects earth over contact *ta*1 to magnet MUB thereby completing the magnet circuit which includes relay RA, at contact *sb*3 connects earth to test relay TA, at contact *sb*4 lights the pilot lamp PL which thereupon glows steadily and at contact *sb*5 extends wire In "A" to wire Out "A" so that a demand from a position connected to switch CSA will be extended to the next sender along the chain. The latch magnet MUB and relay RA operate, the former connecting up the motor which thereupon rotates the switch at high speed in search of the position that created the demand. Relay RA operates its contacts which at contact *ra*1 connects earth to a delayed release alarm device, at contact *ra*2 connects the pilot lamp PL over wire IE to earth, the connection being intermittently interrupted, and at contact *ra*3 opens the original operating circuit for relay C. The position creating the demand is marked by battery potential on the wire connected to the banks of wipers 13 of the coupling switch and when the marked contact is reached relay TA operates and at contact *ta*1 short circuits its right hand winding and removes a short circuit from relay B. The resistance in the circuit of magnet MUB is now too high for the magnet to remain held so the latter falls and stops the motor. Relay B operates. Contact *b*1 connects battery over a resistance to relay B to hold the relay and opens a point in the circuit of magnet MUB. Contact *b*2 disconnects earth from relay C and connects earth to lamp PL, contact *ra*2 now being back since relay RA released with the magnet MUB, and lamp PL continues to glow steadily, contacts *b*3, *b*4, *b*5 and *b*6 connect wipers DD2–DD5 of the digit distributor to wipers 1–4 of switch CSA and thence to the corresponding wipers of switch CSB in readiness for digit reception and contacts *b*7 and *b*8 connect earth to a number of circuits including one to relay BA. Relay C releases, extends the In start wire to the Out start wires and releases relay SB. During the time relay C is operated relay CO cannot be operated as the only possible circuit for the latter relay at this time is over contact *c*3. Relay BA operates. Contact *ba*1 disconnects earth from the homing circuits for the motor-driven coupling switches and connects earth to wiper 16 of switch CSB to light a lamp at the position to indicate that a sender has been taken into use. Contact *ba*2 is without useful effect at the moment, contact *ba*3 connects a termination consisting of a 600 ohm resistance and a 2 microfarad condenser to wipers 9 and 10 and thus across the X and W out-sending wires, contact *ba*4 connects relay F to wiper 7 in preparation for a signal denoting that keying up has finished, contact *ba*5 disconnects earth from the homing circuit for the digit distributor and connects earth to the holding wire for the register relays

and closes a self stepping circuit over the first contact, contact *ddm* of the magnet DDM and the magnet in which the digit distributor is stepped to its second position, contact *ba*6 connects contact 1 in the bank of wiper SD5 with the commoned contacts of the bank, and contact *ba*7 connects relay ZS to wire SP of a 30 second pulsing device. Reference to this arrangement will be made later. The position is now connected to the sender and the sender is in a condition to receive the first digit of the route designation.

*Main trunk call.*—Such a call is indicated by the registration of 3 coded digits in the sender, the first digit being any numeral but "0" and the first and second digits not being the combination 99, the third digit being "0".

It may here be remarked that the reception of the digit "0" results in the operation of the W and X relays in the sets of register relays and the digit "9" in the operation of the X and Y relays. Relay TC is operated in this class of call to bring about translation of the first two registered digits, the third digit being re-transmitted untranslated.

The digits are transmitted from the key strip by the application of earth to one or more of the wires connected to the banks of wipers 1 to 4 of the coupling switches. On the first digit key being pressed the appropriate relay or relays in register A are operated in series with relay DS. Contacts of the register relays in tree formation mark a contact in the banks of wipers 12 of the translating switches MUC and MUD and in the bank of wiper 6 of the translating switch MUE. The operated relays lock up over their contacts 1 and contact *ba*5. Relay DS operates and at contact *ds*1 closes an operated circuit for magnet DD*m*, contact *ds*2 connects winding (II) of relay VF to wipers 5 of the coupling switches, contact *ds*3 disconects earth from wiper DD8 and contact *ds*4 is without useful effect at the moment. Magnet DDM operates and when the key is released relay DS releases and the magnet armature falls back stepping the distributor to the 3rd position. In this position the second digit is recorded on the register relay set BW—BZ and the distributor is stepped as before to its 4th position. The relays AX, AY, BX, BY not having been operated a circuit exists in this position after the release of relay DS as follows: earth, contacts *b*8, *rs*5, *vf*1, *ds*3, contact *aw*3, or *ax*3, wiper DD8, contact *it*3 one or more of the contacts *ax*2, *ay*5, *bx*4, *by*5, relay TC to battery. Relay TC operates and locks up over contact *tc*1 and starts the hunting of the translation switches. The controller now commences to step by self-interruption until the 17th position is reached. The circuit is from earth over contacts *b*7, *r*11 and wiper SD1 thence over bank contacts 1, 2, or 3, contacts *tc*2, *rs*2, *sdm* magnet SDM to battery. The magnet operates, interrupts its own circuit at its armature operated contact *sdm* and steps the wipers. Over bank contacts 4 and 5 the magnet circuit continues over contacts *ss*5 and *dc*1: over bank contacts 6 and 7 the circuit is the same as that over contacts 1 to 3: over bank contacts 8 and 10 it is over contacts *lc*3 and *tc*2; over contact 9 it is over contact *dc*1; over contacts 11 it is over contacts *lc*4 and *dc*1; over contacts 12 to 16 it is over contacts *lc*2 and *tc*2. Contact *tc*3 prepares a circuit for relay ST to be completed when wiper SD4 reaches its 17th position. Contacts *tc*4 and *tc*5 close circuits for the translating switches MUE and MUC, contact *tc*6 prepares a homing circuit for switch MUD to home this switch should it be off-normal and contact *tc*7 prepares a circuit for relay F, to be completed after the reception of the third digit. The circuit for magnet MUE is from earth over contacts *b*8, *td*1, *tc*4, magnet MUE, relay RA to battery and that for magnet MUC is from earth over contacts *b*8, *tb*1, *sw*3, *tc*5, *ct*5, *cs*2, magnet MUC, relay RA to battery.

The motors are started and the switches commence to hunt for markings applied to their banks in accordance with the register relays operated. Relay RA operates to close the delayed release alarm circuit and to connect intermittent earth to the pilot lamp PL. When the marked contact in the bank of switch MUE is encountered the folowing circuit is closed; earth over contacts *b*8, *ms*6, contact tree of the B register relays, bank contact and wiper 7 of switch MUE, relay TD, wiper 6 of switch MUE, bank contact and cross-connection to the contacts in the contact tree of register relays A, contact *ms*5 to battery. Relay TD operates, releases the latch magnet at contact *td*1 thereby stopping the switch and operates relay ET. Similarly switch MUC is stopped on a marked contact in a similar circuit over wiper 14, relay TB, contact *sy*5 and wiper 12.

If the marking is on switch MUD instead of MUC the latter switch continues to rotate until its last contacts are reached whereupon the following circuit for relay TB is closed; earth over contact *b*8, last contact and wiper 14, relay TB, contact *sy*5, wiper 12 and last contact, shunt around left hand winding of relay SW to battery. Relay TB operates followed immediately after by relay SW. Contact *sw*1 prepares a throw out circuit for the differentially connected right hand winding of relay SW, contact *sw*2 holds relay SW to earth over contact *b*8, contact *sw*3 connects magnet MUD in place of magnet MUC, contact *sw*4 closes a homing circuit over off-normal contact *muconi* for switch MUC and contact *sw*5 opens the homing circuit for switch MUD. Swith MUC homes and relay TB releases and at contact *tb*1 connects up magnet MUD and switch MUD hunts for the applied marking, and when it is found relay TB operates over wipers 14 and 12 of switch MUD to stop the switch.

The period during which relay TB is operated over last contacts of switch MUC, is so short, as the switch is moved off these contacts very shortly afterwards by the operation of relay SW, that relay CT will not be operated if relay ET should have been already operated. Even if relay CT does operate it will be immediately released again without producing any circuit changes. The operation of relay ET closes a circuit over contacts *tb*1 and *et*2 for relay CT, opens the homing circuit of switch MUE at contact *et*1, and prepares circuits for the delay working signalling relay DA at contacts *et*3 and *et*4. Relay CT operates and prepares a holding circuit for itself over its winding (II) at contact *ct*1. Contact *ct*2 connects relays DA to wiper 9 of switch MUD, which if in its normal position extends the connection to wiper 9 of switch MUC, to determine if there is any period of delay on the trunk group marked. Contacts *ct*3 and *ct*4 prepare circuits for relays PY and SY, contacts *ct*5 and *ct*6 open in the hunting circuits for magnets MUC and MUD, contact *ct*7 prepares a circuit for stopping switch MUE on last contacts and contact *ct*8 connects relay N to wiper 15 of

switch MUC or MUD for alternative routing purposes.

Meanwhile the third digit "0" will have been registered resulting in the operation of relays CW and CX and the stepping of switch DD to its 5th contacts. The register relays lock up over their contacts 1 and at contacts *cw*2 and *cx*2 close circuits including contact *d*2 for slow to operate relay CS. Contacts *cw*3, *cx*3 and *cw*4, *cx*4 connect relays PY and SY to wipers 10 and 11 of switches MUC and MUD for the purpose of determining whether a direct or alternative route is to be taken. Contacts 5 of relays CW and CX prepare circuits for the transmission of the digit "0" to the 2nd trunk selector when it has been set by the second transmitted digit contacts 6 open in a possible circuit for relay CO and contacts 7 prepare a holding circuit for relay SS. As a result of the stepping of the distributor to its fifth position after the receipt of the 3rd digit, relay F is operated and this relay locks up over contacts *f*1 and *b*8. Contact *f*2 prepares a circuit for relay CO to be completed when the controller reaches its 23rd position, contact *f*3 opens in a locking circuit for relay SR over winding (II) of that relay and contact *f*4 opens to prevent further operation of the register relays and relay DS. If a direct route is to be taken relay PY operates over its upper winding and locks up over its lower winding and contact *py*1. Contact *py*2 opens to prevent relay SY operating, relay SY being slow to operate so that PY can operate first, contact *py*3 opens in a circuit in parallel with contact *ct*7 now closed, and contact *py*4 disconnects winding (II) of relay RS and connects winding (I) of relay CN in its place. The route to be taken, whether direct or alternative is determined by a group marking relay which maintains earth on the contacts in the banks of wipers 10 and 11 of switches MUC and MUD so long as a free route is available. If the direct trunks of a group are all busy no earth will be present over wipers 10 and if an alternative route is available free earth will be found over wipers 11 and relay SY will be operated. Contacts *sy*1 and *sy*2 perform similar functions to contact *py*1 and *py*2, contact *sy*3 opens the battery connection to the last contact in the bank of wiper MUE6, contact *sy*4 prevents the relay PY operating when relay CS is operated, contact *sy*5 releases relay TB, contact *sy*6 in conjunction with contact *sy*5 prepares an alternative circuit for relay TB, contact *sy*7 prepares a circuit for relay AF and contact *sy*8 closes in the circuit over which the 3rd digit is transmitted to give a different signal to the 2nd trunk selector which prevents this selector or routing the call to a storage equipment if the last alternative route trunk should have become engaged in the meantime.

If an alternative route is to be taken then on the release of relay TB relay CT releases and the translating switch MUC or MUD as the case may be continues to drive until a further marking is found or last contacts are reached. If switch MUC reaches last contacts relay TB operates over wiper 14 and the left hand winding of relay SW. Relay SW transfers the drive to switch MUD and homes switch MUC as before described and switch MUD hunts for the marking. When this is found relay TB operates to stop further drive. If switch MUD had found the original marking and the alternative route is marked on switch MUC then MUD would be driven to last contacts. Relay SW would have been operated and when last contacts are reached the right hand winding of relay SW is energised over wiper 13 and relay TB and relay SW is released by differential action to transfer the drive to switch MUC and home switch MUD. Relay TB operates when the marked contact is found over wiper 13, bank contact and wiper 8 of switch MUE to battery and relay CT is re-operated. The operation of relay CS has the following results: contact *cs*1 locks the relay, contacts *cs*2 and *cs*3 open in the driving circuits of magnets MUC and MUD, contact *cs*4 operates relay PY if this relay or relay SY is not already operated and contacts *cs*5 to *cs*8 connect the relays of the G register set to wipers 1, 3, 5, and 7 of the translation switch MUC or MUD. The contacts in the banks of these wipers are earthed in accordance with the code of the first digit to be sent out and the contacts in the banks of wipers 2, 4, 6, 8 are earthed in accordance with the second digit to be sent out. Accordingly one or more of the relays of the G register set are operated.

When the controller reaches its 17th position relay ST was operated, the circuit being from earth over contacts *rs*3, *b*7, wiper SD4, contacts *tc*3, *rl*3, right hand winding of Relay ST to battery. Relay ST locks up over its left hand winding, contacts *st*1, *rl*1, *b*7, and *rs*3. Contacts *st*2, *st*3, *st*5 and *st*6 extend the out-sending signalling wires over wipers 10, 9, 8 and 6 of the coupling switch to wipers SD7, SD3, SD2, and SD6 in preparation for the transmission of the digits for setting the trunk selectors and disconnect the terminating impedance, and contact *st*7 completes the out-sending circuit. It will be assumed here that the route to be taken is a direct route and that relay PY has been operated. The first translated digit is transmitted depending on the relays of register G operated over the odd numbered wiper of switch MUC. The out-sending circuit is from battery over contact *tti*, high speed relay TS, relay TT, contact *st*7, contacts 2 of one or more of the relays GW, GX, GY, GZ 17th contacts in the banks of the controller, the corresponding wipers, the out-sending wires to earth over code receiving relays in the 1st trunk selector. Relays TT and TS operate in this circuit, contact *ts*1 maintaining the circuit after operation of relay TT. When the first trunk selector has been set earth is disconnected thereat from the digit transmission circuit and relay TS releases. Relay DC operates over contacts *tt*2 and *ts*1 during the release of relay TT which follows that of relay TS and at contact *dc*1 closes a self-stepping circuit for switch SD which steps to contacts 18 and on the subsequent release of relay DC following the release of relay TT steps over the bank contact *dc*1 to the 19th contact position. Contact *dc*2 closes a circuit for relay DE but the operation of this relay is without useful effect in the type of call under consideration. The relays of register G are released at contacts *dc*3 to *dc*6. In position 18 of switch SD relay FD operated over wiper SD4 and is maintained operated in position 19 of the switch. Contacts *fd*2 to *fd*5 disconnect wipers 1, 3, 5, 7 of switch MUD and substitute wipers 2, 4, 6, 8 so that when relay DC releases the relays of the G register are connected to these latter wipers over which a translation for the second digit is found which brings about the re-operation of one or more of these relays. This second digit is transmitted in a similar manner to the first and sets the 2nd trunk selector to the beginning of the desired trunk group. Re-

lays TS, TT and DC operate as before described and switch SD steps to position 21, relay FD being released in position 20, in preparation for the transmission of the 3rd digit which in the present example is "0" represented by the operation of relays CW and CX. This digit is transmitted in a similar manner to the 1st and 2nd digits and the circuit includes contacts *cw5*, *cx5* and wipers SD7 and SD3. This digit causes the 2nd trunk selector to hunt in the marked group and when relay DC subsequently operates switch SD is stepped to contacts 23. In this position of switch SD a circuit is closed from earth over wiper SD8, contacts *ad8*, wiper DD7 in position 4, contacts *rm6*, *f2*, *sy7*, *cn2*, relay CO to battery. Relay CO operates and locks up over contact *co1*. Contact *co2* applies earth over contact *ba2* to wiper 11 of switch CS to bring about at the position circuit the opening of holding circuit and the release of relay TS, contact *co3*, opens to prevent operation of relay C whilst release of the register sender is taking place, contact *co4* connects the intermittent earth wire to lamp PL when relay RA is not operated, contact *co5* earths wiper SD8 until relay B has released, and contact *co8* closes the delayed alarm circuit. Following the release of relay TA relay B is short circuited and released and earth is disconnected from the principal relay circuits at contacts *b7* and *b8*. Relay BA releases and at contact *ba1* closes the homing circuit for the switches MUA and MUB over their off-normal contacts *muaon1* or *mubon1* as the case may be and extinguishes the lamp at the operator's position. As a result of the opening of contact *b7* relays ST, DE release and as a result of the opening of contact *b8* relays TC, TB, TD, F, ET, CT, CS and SW if operated and PY release. The homing circuit for switches MUC, MUD and MUE are closed over contacts *mucon1*, *mudon1* and *mueon1* respectively and these switches are driven rapidly to their normal position. Following on the release of relay BA the homing circuit for the distributor is closed over contact *ba5*, wiper DD1 and self-interrupting contact *ddm*, and that for the controller over wiper SD5, contacts *rs1*, *ba6* and self-interrupting contact *sdm* and these two switches are homed by self-interruption of their magnet circuits. When all the switches have reached their normal position a short circuit for relay CO is closed over contacts *co5*, *so3*, wiper SD3, contacts *f2*, *rm6*, wiper DD7 and series connected off-normal contacts of the motor-driven switches and relay CO releases restoring the register sender to a condition for further use by the closure of contact *co3*. Relay C thereupon operates and connects relays SA and SB to the chain start circuit.

If an alternative route is to be taken relay SY will be operated instead of relay PY and switch MUC or MUD hunts for the alternative route marking in the manner previously described. The 3rd digit in this case is transmitted as "W, X, Y," contact *sy8* closing in the out-sending circuit over wiper SD2 in its 21st position. The effect of this code is to set the 2nd trunk selector searching and to prevent its routing the call to a storage position.

With contact *sy7* in its front position relay AF operates when wiper SD3 is stepped to its 23rd position and at contact *af1* connects flicker earth to wiper 16 of the coupling switch to signal the operator that digit transmission has been completed and an alternative route taken. The operator may now press a "cancel" key which brings about the release of relay TA and by connecting earth to the contact in the bank of wiper 14 of the coupling switch operates relay CO via contact *c3* and points (1) and release of the register sender takes place.

If there is not an alternative to the direct route or no alternative route is available neither relay PY nor relay SY will be operated over the wipers of the translating switch but on the operation of relay CS relay PY will be operated over contacts *sy4* and *cs4* and the 2nd trunk selector will store the call.

If the last free alternative route trunk becomes busy while the 2nd trunk selector is hunting the selector will be stopped in a "group busy" position in which battery will be applied to the "Z" signalling wire resulting in the operation of relay RS over the "Z" signalling wire, wiper SD6 in position 22, contacts *mt5* and *py4* and winding (II) of relay RS. Contact *rs1* disconnects contact 17 in the bank of wiper SD5 and connects earth over the wiper and commoned contact to magnet SDM and over contact *rs2* to winding (I) of relay RS to hold the relay. Switch SD now self-steps over the above traced circuit until position 17 is reached, contact *ba6* being included in the circuit in position 1 of the switch and contact *so1* in position 4. Contact *rs3* opens to prevent operation of relay AF in position 23 and releases relay ST. Contact *rs4* operates relay PY which thereupon locks up over contact *py1* and releases relay SY, and contact *rs6* connects earth to wiper 5 of the coupling switch to transmit a signal to bring about the release of the trunk selector. In position 17 of the switch SD relay RS is released. Relay SY having been released the translating switch drives off in search of the direct route marking. The digits for setting the trunk selector to a trunk in a direct route are transmitted and the call is stored by the 2nd trunk selector.

If the alternative route taken leads to an automatic exchange it will be necessary to set switches in that exchange for completing the connection to the desired exchange. Alternative routes that require the transmission of an additional digit are marked by an additional marking on switches MUC and MUD so that relay N is operated over contact *ct8* and wiper 15 of the translating switch. Relay N locks up over its left hand winding and contact *n1* and *b8*, at contact *n2* prepares a circuit for the possible operation of relay RS over its winding (I) and at contact *n3* closes a circuit for relay AD over contacts *sy1* and *py1*. Relay AD operates and at contacts *ad1* to *ad4* connects the relays of the D register to wipers 1 to 4 of switch MUE. Contact *ad5* removes a short circuit from winding (I) of relay SO to allow that relay to operate after the 3rd digit has been transmitted contact *ad7* disconnects relay AF and prepares an alternative circuit for the operation of relay CO and contact *ad8* opens to prevent operation of relay CO in position 23 of the controller. One of more of the relays of the D register are operated according to the marking found on the bank contacts of wipers 1 to 4 of the switch MUE. After the 3rd digit (CW, CX, SY) has been transmitted the controller is stepped from position 21 and in position 22 the following circuit is completed: earth over contacts *rs3*, *b7*, *rl1*, wiper SD1 in position 22, winding (I) of relay SO, contacts *dc1*, *rs2*, *sdm*, magnet SDM to battery. Relay SO operates and at contact *so1* connects winding (II) of relay SO in a circuit for magnet SDM

over commoned contacts and wiper SD5 and the controller is stepped until position 4 is reached where the stepping circuit is found open at contact *so1*. Relay SO releases. Consequent on the operation of relay SO contact *so2* closes an operating circuit for relay SS over its left hand winding, contact *so3* opens the releasing circuit to prevent operation of relay CO while the controller is in position 25 and contact *so4* closes a circuit for winding (I) of relay VF over contacts *ra5* and *b8*. Relays SS and VF operate and contact *ss6* locks relay SS over its left hand winding and in conjunction with contact *vf7* locks relay ST independently of contact *rl1*. Contacts *ss1* to *ss4* disconnect the out-sending wires from the wipers of the controller and connect them as follows. Wires W and X over contacts *ss4* and *ss3*, *vr4* and *vf5* to a source of voice frequency current dependent on closure of contact *ar1*, wire Y over contacts *ss2* and *vf2* to battery dependent on contact *as1*. Contact *ss5* prepares a stepping circuit for the controller in position 11, contacts *vf3* short circuits relay VA and connects a termination consisting of a condenser and resistance in series in the voice frequency current supply circuit and contact *vf6* closes an operating circuit over contact *so2* for relay S. At contact *s2* earth over contacts *rs3*, *b7* and *rl1* is extended over contacts *cn3*, *co6*, *sr3*, *dp3*, and *vc3* to winding (I) of relay SN which operates and at contact *sn1* closes a circuit over contacts *sn1* and *s1* for relay A. Contacts *s4*, *s5* and *s6* connect relay SZ to wipers SD2, SD3, and SD7, the connection to wiper SD6 being made over contact *ss1* and contact *s7* closes in the connection to the first contact in the bank of wiper SD7. Contact *sn1* closes an operating circuit for DQ over its right hand winding and a circuit for relay X over the back contact of armature *a2*, contact *sn3* prepares locking circuits for the counting relays and contact *sn4* prepares an operating circuit for relay CO. Relay X operates. Relay A is an impulse generating relay and the circuit for one of its windings includes a make-before-break contact controlled by relay A itself and the other winding is connected in parallel with the first over a condenser or condensers, the condensers connected depending upon rate of impulsing required. The relay on operating opens its operating circuit at contact *a1* and connects earth over contacts *sn1* and *s1* to relays AR and AS and at contact *a2* extends earth over relay X and contact *x1* to the counting relays. Contacts *ar1* and *as1* close signalling circuits as follows: contact *ar1* completes the voice frequency signalling loop for the transmission of voice frequency impulses over the trunk to the intermediate exchange in the connection and contact *as1* connects battery over contact *sz2* to wire Y for the transmission of D. C. leg impulses. The distant switches will respond to the voice frequency impulses brought about by release and operation of relay AR and the D. C. impulses will be without effect as they will be suppressed at an outgoing repeater. At contact *x* a circuit is closed in series with relay X over contacts *cd2*, *cc2*, *cc3*, *cb2*, *cb3*, *ca2*, *cb4* for the right hand winding of relay CA. Relay CA locks up over contacts *ca1* and *sn2* short circuiting relay X, and at contact *ca2* disconnects its operating circuit and connects up relay CB over contacts *cc4*. Before this occurs relay X which is quick to operate and release has released. Contact *ca3* connects relay SZ to wiper SD7. In position 4 of the controller earth over contact *ba5* and one or more of the locking contacts *dw1*, *dx1*, *dy1*, *dz1* is connected to the 4th contacts in the banks of wipers SD6, SD2, SD3, SD7. If only one impulse is to be transmitted relay SZ will operate over wiper SD7 and contact *dz1* to terminate impulse transmission. If more than one impulse is to be transmitted relay SZ will be short circuited over one or more of the contacts *cd4*, *cc5*, or *cb5* and the relevant locking contacts of the register relays and succeeding impulses generated by the continued operation and release of relay A will cause relays CB and so on to be operated in turn and at the same time impulses will be transmitted at contact *ar1*. When no short circuit for relay SZ exists that relay operates from earth over the relevant register relay locking contact or contacts, front contacts of the counting relay or relays, contact *as1*, to battery. A more detailed description of the operation of the impulse generating and counting arrangement is given in British Patent Specifications Nos. 462,773 and 471,987. Relay SZ locks up over contacts *vc2*, *sz1*, *b7* and *rs3* and at contact *sz2* opens the D. C. leg signalling circuit and prepares for the possible operation of relay RS, and at contacts *sz3*, opens the voice frequency impulsing loop and connects the condenser and resistance formerly included in the circuit over the wire W across the trunk as a termination. Relay SR operates in the locking circuit of relay SZ and at contact *sr3* releases relay SN. contact *sr4* opens the operating circuit for relay SZ. contact *sr5* prepares a holding circuit for relay VC and contact *sr6* prepares an operating circuit for relay DP. Contact *sn1* opens the circuit for relays A, AR, and AS, contact *sn2* releases relay DQ and contact *sn3* releases the operated counting relays. Release of relay DQ closes a circuit over contacts *b8*, *ar6*, *dq1* and *dp1* for winding (I) of relay DP. Relay DP operates and locks up over contact *dp1*. Contact *dp3* recloses the circuit for relay SN over the front of contact sr3. Relays SN, DQ and A re-operate and relay A generates impulses for measuring off a pause to permit of a reverted signal being received before the register sender is released. Contact *dp4* permits a different capacity being connected to relay A to alter the speed of impulsing. Operation of relays AR and AS is ineffective because the impulse repeating circuits are open at contacts of relay SZ. The counting relays allow 10 impulses to be counted whereupon relays CA, CB and CC being operated a circuit is closed over contacts *b8*, *dp2*, *cb6*, *cc6* and *ca4* for the left hand winding of relay VC. Relay VC operates and locks up over contacts *vc1* and *sr5*. Contact *vc2* prepares for the release of relay SZ by leaving that relay dependent on continued closure of contact *dq1*, contact *vc3* releases relay SN. Relay DQ releases and releases relays SZ and SR, and relays DP and VC thereupon release. The counting relays are released. Relay VC is slow to release and after the release of relay SR a circuit is closed from earth over contact *sr2*, winding (II) of relay DP, contact *vc4*, magnet SDM to battery. The magnet operates and on the release of relay VC steps the controller to its 5th position. In this position earth over wiper SD8 is extended over contact *ad8*, 5th contact in the bank of wiper DD7 contacts *rm6*, *f2*, *sy7*, *ad7*, *cn2* to relay CO. Relay CO operates and the register sender is released.

If the distant selector encounters congestion a signal of voice frequency current is reverted and at an outgoing repeater in the trunk exchange or other convenient circuit is converted into a D. C. signal in the form of earth applied to wire Y. This signal is received during the measured pause after the transmission of the voice frequency impulses and operates relay RS, the circuit being over wire Y, contacts *st*5, *ss*2, *vf*2, *sz*2, *n*2 and winding (I) of relay RS. Relay RS locks up over this winding, contacts *rs*2, *rs*1, *so*1 and wiper SD5 in position 4 and the controller is stepped to position 17 where it is stopped by reason of the connection to the 17th contact in the bank of the wiper SD5 in the switch magnet stepping circuit being open at contact *rs*1. Relay RS holds during the stepping of the controller in the manner previously described. Contact *rs*4 operates relay PY which releases relays SY and AD at contact *sy*1. The connection is released consequent on the closure of contact *rs*6 and the switches in the trunk exchange are set to store the call in the manner before described.

If the operator wishes to route the call via a direct route irrespective of whether this route is congested or not she presses a special key instead of the key "0" for the 3rd digit. This results in the operation of relays CW, CX and CY. Relay PY is thereupon operated by means of its upper winding over contacts *sy*2, *cx*3, *cw*3, *ct*3 and *cy*3 independently of the translating switches and the call is routed via the direct route or stored as the case may be.

If in the setting up of a connection over either a direct or an alternative route the 1st trunk selector encounters congestion relay RL is operated. In the type of call under consideration this occurs in position 18 of the controller. The congestion signal is the application of battery to the Z wire and this effects the operation of relay RL over wiper SD6, contacts *sn*5, *rm*6 and winding (I) of the relay. The relays locks up in series with winding (II) of relay DC over contacts *rm*5 and *rl*1. Relay DC being held the self-stepping of the controller is prevented. Contact *rl*3 prepares a circuit for relay RM. At contact *rl*1 relay ST is released and a circuit is closed over contacts *s*1 and *a*1 for relay A which commences to generate impulses. The speed of impulsing is controlled by contact *rl*2 which nullifies the effect of the change over of contact *fd*1. Contact *rl*4 connects earth over contacts *rl*1, *s*1 and *a*1 to magnet SDM so that this magnet is operated at each release of relay A whereby the wipers of switch SD are stepped slowly round their banks to measure off a time interval. Contact *rl*5 removes a short circuit from winding (I) of relay DC to ensure that this relay releases before relay RL. Earth is applied to wiper 5 of the coupling switch over contact *rl*6 to bring about the re-setting of the 1st trunk selector to its normal position. The controller is stepped until contact 17 is again reached whereupon relay RM is operated over wiper SD4, contacts *tc*3, *rl*3, and the right hand winding of the relay. The relay locks up over contact *rm*1 and at contact *rm*5 releases relays RL and DC and stops further impulse generation by relay A. Contact *rm*4 substitutes winding (I) of relay CN for winding (I) of relay RL in the connection to contact 18 in the bank of wiper SD6, contact *rm*3 prepares a circuit for the left hand winding of relay RM over contact 23 in the bank of wiper SD4 and contact *rm*6 opens in the circuit over wiper DD7 for relay CD. Release of relay RL operates relay ST at contact *rl*3 and the locking circuit for relay ST is re-prepared at contact *rl*1. The first digit is again transmitted and if the first trunk selector is able to find a free outlet in the required group the remainder of the digits are transmitted as before described and when switch SD reaches position 23 the left hand winding of relay RM is energised to release the relay by differential action. If, on the contrary, congestion is still encountered relay CN operates over the Z wire and locks up over its winding (II) and contact *cn*1.

Contact *cn*4 applies earth to wiper 12 of the coupling switch which is extended to the position circuit to light a lamp thereat indicating a state of congestion. The operator presses the "cancel" key operating relay CO to initiate release of the register sender.

If a dead number is keyed no cross connection will be present to the banks of switches MUC and MUD. Switch MUE tests on the contacts marked by the A and B registers or if no contact is marked it drives to a last contact position in which relay TD operates in a circuit from earth over contact *b*8, last contact and wiper 7 of switch MUE, relay TD, wiper 6 and last contact, contacts *sy*3 and *py*3 to battery. Relay ET operates. Switch MUC drives to last contacts where it is stopped by the operation of relay TB in a circuit from earth over contact *b*8, last contact and wiper 14 of switch MUC, relay TB, contact *sy*5, wiper 12 and last contact, left hand winding of relay SW to battery. Relay SW operates and locks up over contact *sw*2. Contact *sw*4 closes the homing circuit for switch MUC which is driven to normal. Relay TB releases. Earth over contacts *tb*1 and *sw*3 is now extended to magnet MUD and switch MUD drives to its penultimate contacts whereupon relay TB reoperates from earth over contacts *b*8, penultimate contact and wiper 14 of switch MUD, relay TB, contact *sy*5, wiper 12 and penultimate contact, contacts *sy*3 and *py*3 to battery. Relay CT operates and a circuit is closed from earth over winding (II) of relay SN, penultimate contact and wiper 15 of switch MUD, contact *ct*8, right hand winding of relay N to battery. Relay SN operates but relay N does not. Contact *ct*7 holds relay TD against the operation of relay PY which is about to take place. After the third digit has been registered relay CS is operated and contact *cs*4 closes a circuit in which relay PY operates. Meanwhile the controller has reached position 17 and relays ST and F have been operated. The relays of the G register are connected by contacts *cs*5 to *cs*8 to wipers 1, 3, 5, 7 of switch MUD and the penultimate contacts on the banks of these wipers are cross connected to bring about the operation of relays GW, GX and GY. The out-sending circuit is now closed over relays TS and TT, contacts 2 of relays GW, GX and GY and the 1st trunk selector is set to contacts associated with a source of NU tone which is thereupon transmitted to the operator. On the release of relay TS relay DC operates and switch SD is stepped to position 18 in which winding (I) of relay CN is connected over contact *sn*5 to wire Z. In the N. U. tone position of the 1st trunk selector battery is connected to wire Z resulting in the operation of relay CN. Relay CN locks up over its winding (II) and contact *cn*1, contact *cn*2 closes a circuit over contact *sn*4 for relay CO, contact *cn*3 releases relay SN, contact

*cn*4 connects earth over wiper 12 of the coupling switch to light a lamp in the position circuit and contact *cn*5 prepares a connection to an overflow meter which is ineffective in the present case. The operation of relay CO brings about the release of the register sender. The aforementioned operations presuppose contacts available on the 1st trunk selector for N. U. T. purposes and the utilisation of the code W, X, Y for this purpose. If for any reason these facilities are not available, and the code W, X, Y effects the setting of the 1st trunk selector to a free 2nd trunk selector, a second digit must be transmitted to set the 2nd trunk selector to N. U. T. contacts. This is taken care of by suitable cross connections to the penultimate contacts in the banks of wipers 1, 3, 5, 7 of switch MUD. After the transmission of the first digit switch SD steps to position 18 in which relay FD is operated and then to position 19 in which relay FD is held. Contacts 2 to 5 of relay FD connect the G register relays to wipers 2, 4, 6, 8 of switch MUD, and a translation provided by means of cross connections to these contacts causes the 2nd trunk selector to drive to the contacts connected to the source of NU tone which is thereupon transmitted to the operator. Relay CN operates as before to initiate the release of the register sender.

If a connection is to be made to an individual trunk the 3rd digit will not be "0" but one of the digits 1 to 9. In this case relays CW and CX will not be operated so that relays PY and SY cannot operate over the group control connections. After the third digit has been received relay CS operates and at contact *cs*4 closes an operating circuit for PY and the call is set up as previously described for a call via a direct route with the exception that the third digit, which is untranslated is a number other than "0."

If, under any of the conditions before referred to delay working on a group of trunks is in force a distinguishing potential will be present on the relevant contacts in the banks of wipers 9 of switches MUC and MUD for main trunk groups and in the bank of wiper 5 of switch MUE for minor trunks. After the second digit has been registered and switch MUE has found the contact marked by the relays of the A and B registers relays ET and CT are operated. Contacts *et*3 and *et*4 connect the two windings of relay DA in series and their mid-point to wiper 9 of switch MUD over contacts *d*4 and *ct*2. If no potential is present on the bank contact relay DA is not operated because its windings are connected in opposition. If delay working is in force the bank contact will have one of three potentials applied to it; either (*i*) flicker earth and battery (*ii*) interrupted earth and battery or (*iii*) steady earth. In any of these cases relay DA will operate on one or other of its windings and at its contact *da*1 will connect relay D over contacts *db*1 and *b*8 to earth. Relay D operates and locks up over contact *d*1. Contact *d*2 opens to prevent operation of relay CS, contact *d*3 connects winding (II) of relay DB to wiper 7 of the coupling switch, contact *d*4 disconnects relay DA and extends the connection over wiper 9 of switch MUD to wiper 15 of the coupling switch over points (3) and contact *st*4 and contact *d*5 holds relay CT over its winding (II) and contacts *ct*1, *cs*4 and *b*8. The delay signal is thereby repeated to the position circuit where a lamp is flickered, flashed or caused to glow steadily to indicate one of three periods of delay to which calls over the group of trunks in question will be subject. The register sender is released without any digits being transmitted by the depression of the cancel key by the operator whereby relay CO is operated over wiper 14 of the coupling switch.

*Minor trunk calls*

Calls to these trunks are made by keying the numerals 990 which effect the setting of the 1st and 2nd trunk selectors leading to the 3rd trunk selectors to which minor trunks are connected. Two more digits are then keyed to select the minor trunk group required. In a call of this kind switches MUC and MUD are not driven in search of a marking as relay TC, the operation of which is necessary for the starting of switch MUC, will not be operated in position 4 of the distributor as its connection to the bank of wiper DD8 will be open at contacts of the A and B register relays. The numeral 9 is represented by the code XY so that relays AX, AY, BX, BY will be operated by the first two digits and contacts of each of these relays will open the only possible operating circuit for relay TC. In the C register relays CW and CX will be operated and after receipt of this digit which DD will be stepped to position 5. The 4th digit will be received on the relays of the D register and the 5th digit on the E register after which the distributor will be stepped to its 7th position. In this position earth is connected over contacts *b*8, *rs*5, *vf*1, *ds*3, *aw*3, wiper DD8, relay MS, contact *it*1, to relay MT and relays MS and MT operate. Contact *ms*1 closes an operating circuit for relay F, contact *ms*2 connects up magnet MUE over the back contact of armature *tc*4, contact *ms*3 prepares the circuit for relay CT in the place of contact *tb*1 since relay TB will not be operated and contacts *ms*5 and *ms*6 disconnect the marking contacts of the A and B registers and connect contacts of the relays of the D and E registers to the marking terminals which are cross connected to the marking switches. Contact *mt*2 holds relays MS and MT independently of switch DD, contact *mt*5 closes a circuit for stepping switch SD to position 17 similar to that closed by relay TC, contact *mt*4 prepares a circuit for relay ST similar to that closed at contact *tc*3, contact *mt*5 connects winding (I) of relay RL in place of winding (II) of relay RS and contact *mt*6 closes in the delay signalling wire for minor trunks over wiper 5 of switch MUE. Switch MUE is driven in search of the contacts marked by the D and E register relays and is stopped by the operation of relay TD as in the case of a main trunk call. Relays ET, CT and CS are operated. Contact *cs*4 operates relay PY and contacts *cs*5 to *cs*8 connect the relays of the G register to wipers 1, 3, 5, 7, of switch MUD. In position 17 of the controller relay ST is operated and locked and the out-sending wires are connected by switch SD to battery over contacts of the operated relays of the G register and relays TT and TS. The normal contacts in the banks of wipers 1 to 8 of switch MUD are marked in a manner which will bring about the setting of the 1st and 2nd trunk selector to an outlet to a free 3rd trunk selector and the first digit transmitted will be in code form and in accordance with the operation of the relays of the G register operated by the marking provided over wipers 1, 3, 5, 7 of switch MUD. After the digit has been transmitted the relays of the G register are released and switch SD is stepped to position 19 and in passing position 18 relay FD is operated to connect the relays of the G register to wipers 2, 4,

6, 8, of switch MUD whereby the second translated digit is transmitted. After the transmission of this digit the relays of the G register are released and the controller is stepped to position 21, relay FD releasing in position 20.

In position 21 the code WXY is sent out consequent on the closure of contacts *cw*5, *cx*5, and *ms*7, to prevent the call being stored if congestion is encountered by the 2nd trunk selector after which switch SD steps to position 23. Since wiper DD7 is not resting in position 5 but in position 7 no circuit is made for relay CO and wipers SD6, SD2, SD3 and SD7 are connected over those contacts *dw*3, *dx*4, *dy*5, *dy*6 of the relays of the D register which have been operated and the 4th digit transmitted is in accordance with the 4th registered digit. Switch SD is then stepped to position 25 in which the digit transmission circuit is completed over those contacts *ew*3, *ew*4, *ew*5, *ew*6 of the relay of register E which have been operated. After this digit has been transmitted and relay DC has been operated, earth over wiper SD1 is extended over relay MC and contact *dc*1 to magnet SDM. Relay MC operates and at contacts 1 to 4 opens the out-sending circuit and at contact *mc*5 operates relay CO which brings about the release of the register sender.

In calls of this type the 2nd trunk selector gives access to 3rd trunk selectors and relay MT is operated and locked. In congestion is encountered by the 1st trunk selector the action is as described in connection with a main trunk call. If congestion is encountered by a 2nd trunk selector the selector will drive to an overflow position in which a circuit will be completed for relay RL over wire Z, wiper SD6 in position 22, i. e. after the controller has stepped on after the transmission of the 3rd digit, contacts *mt*5, *rm*4, and winding (I) of the relay. The controller is stepped round to position 17 and action thereupon takes place as described for a main trunk call. If congestion is encountered a second time relay CN is operated and with wiper SD4 in position 22 an overflow meter is operated over that wiper and contact *cn*5.

If a dead number is keyed the 3rd trunk selector is driven to a position in accordance with the 4th and 5th digits keyed and the relevant contacts in this trunk selector will be connected to a source of N. U. tone.

If a number other than 0 be keyed for the 3rd digit the 2nd trunk selector will be driven to a position from which N. U. tone is given. It may be noted that the 2nd trunk selectors taken into use for a minor trunk call are in a different group from those in a main trunk call, a numeral other than 0 setting trunk selectors of the latter group to an individual trunk in a selector group. Release of the register-sender in the case of a wrong 3rd digit takes place by the operation of relay CO in position 22 of switch SD over wiper SD8 and contacts *ms*4 and *cw*6 or *cx*6.

If delay working is in force relay DA will be operated over contacts *mt*6 and wiper 5 of switch MUE and the appropriate signal will be transmitted to the operator, relay D operating and preventing operation of relay CS whereby digit transmission is prevented. If, instead of depressing the cancel key to operate relay CO and release the register sender the operator presses a "finish" key, earth is connected over the contact in the bank of wiper 5 of switch CS and relay DB is operated by means of its winding (I) and relay F is held. Relay DB locks up over its winding (II) and contact *db*1, releasing relay D thereby permitting digit transmission to proceed.

*Trunk calls requiring the keying of additional digits*

When the register sender is taken into use a 1st trunk selector is seized and after the transmission of the first three code digits the sender is automatically released. If, however, the operator should have to transmit further digits the sender can be caused to re-associate itself with the position and the 1st trunk selector even though it is busy and the further digits, up to 7 in number can be keyed up and registered in the register sender. These digits are sent out as trains of voice frequency loop impulses. After the register sender has become connected to the 1st trunk selector the distributor is stepped to position 2 and the first additional digit is registered on the A register. Relay DS operates and at contact *ds*2 connects winding (II) of relay VF to wiper 5 of switch CS. In the engaged condition of the 1st trunk selector earth is connected to the contact in the bank of wiper 5 of the coupling switch and relay VF operates and locks up over its winding (I). The change over of contact *vf*1 prevents operation of relay TC and consequent translation of the keyed up digits.

Closure of contact *vf*6 operates relays S and SS and following on the operation of relay SS and closure of contact *ss*6 relay ST operates over contact *vf*7 and the left hand winding of the relay. Relays VF and SS connect the W and X wires to the source of voice frequency current, the circuit including the contact *ar*1, and contact *s*3 closes in a circuit over contact 8 in the bank of wiper SD8. Relay SN is operated at contact *s*2 to operate relay A to start impulse generation and counting, relay AR operating at each release of relay A to close the voice frequency impulsing loop. At the same time a leg circuit is closed over contact *as*1 and wire Y but these impulses are without effect: either they are ignored at the outgoing repeater or are suppressed. The impulse counting relays are operated in succession until relay SZ operates consequent on earth being found over one or more of the operated contacts *ca*3, *cb*5, *cc*5, *cd*4 and absence of earth over the unoperated contacts, the earth being applied over the locking contacts of the relays of the A register and wipers of the controller in position 1. The operation of relay SZ terminates the impulse train by opening the loop and operating relay SR which effects release of relays SN and DQ and the timing of the inter-train pause.

At the end of the pause which is measured by the time taken to generate 8 impulses relay VC is operated and relay SR released whereupon magnet SDM is operated over contact *sr*2, winding (II) of relay DP and contact *vc*4 during the slow release of relay VC. When relay VC releases the controller steps to position 2 and relay DP releases to reclose the circuit for relay SN at contact *dp*3. By this time other digits will have been registered and these are transmitted in a similar manner over the wipers of the controller in position 2 and succeeding contacts until all the keyed digits have been transmitted. After the operator has keyed the last digit she presses the "finish" key and relay F is operated by means of its winding (II). When the last digit has been transmitted the circuit for relay CO is now completed over wiper SD8 in position 8, contact *s*3

and wiper DD7 in position 9 and the register sender is released.

*Special trunk calls*

Special trunks are trunks between important centres and calls to be made over them are set up by keying a special digit as a first digit, any of the numbers 1 to 0 as the second digit and "0" as the third digit. The special digit is represented by the code WXY and this is translated to the code WXZ for transmission to the 1st trunk selector.

After the registration of this digit and the operation of relays AW, AX, AY the distributor is stepped to position 3. Relay IT is operated in a circuit from earth over contacts *b*8, *rs*5, *vf*1, *ds*3, *ax*3, *aw*2, *ay*6, left hand winding of relay IT to battery. Relay IT locks up over contact *it*1 and relay MT. Contact *it*2 closes to maintain earth on wiper DD8, contact *it*3 opens the operating circuit for relay TC and contacts *it*5, *it*7 and *it*8 connect earth over contacts *de*2, *de*4, and *de*5 to operate relays GW, GX and GZ. Consequent on the operation of relay MT and closure of contact *mt*3 switch SD steps to position 17 in which position relay ST is operated and locked up. The digit transmission circuit is closed and the code WXZ is transmitted for the setting of the 1st trunk selector and the controller is stepped to position 19. During the time relay DC is operated after the transmission of the special first digit a circuit is closed for relay DE from earth over contacts *rs*3, *b*7, *rl*1, *it*4, *dc*2 relay DE to battery. Relay DE operates and locks up over contact *de*1 and at contacts *de*2 to *de*5 connects the relays of the G register after release of relay DC, over the locking contacts of relays BW, BX, BY and BZ and contact *ba*5 to earth.

By this time the second digit has been recorded and relays GW to GZ are operated according to the digit received over the locking contacts of the operated relays of the B register and contacts of relays DC, IT and DE to close circuits over the appropriate out-sending wires for the setting of the 2nd trunk selector. After the second trunk selector has been set relay DC is operated the relays of the G register are released and switch SD stepped to position 21. The 3rd digit is registered by relays CW and CX but relays CS and CT are not operated. The 3rd digit, like the second is transmitted without translation but the out-sending wires are marked by closure of contacts *cw*7 and *cx*5. After registration of the 3rd digit the distributor is stepped to position 5 and after transmission of this digit switch SD is stepped to position 23. A circuit is now closed from earth over wiper SD8, contact *ad*8, and wiper DD7 for relay CO, relay F being operated in position 5 of the distributor over contact *it*2, wiper DD8 and contact *mt*1. Relay CO operates and release of the register sender takes place.

Congestion encountered by the 1st trunk selector results in the operation of relay RL as in the case of a main trunk call and congestion encountered by the 2nd trunk selector results in the call being stored.

*Local calls*

Calls to be completed locally are made by prefixing the directory number with the numeral "0." The first digit "0" effects the setting of the first trunk selector and the second digit effects the setting of the first local selector. Any further digits are transmitted as impulses and set numerical selecting switches in the usual manner. If the call is to a manual exchange in the area only two digits are keyed followed by the depression of the "finish" key. The first key pressed is the "0" key and results in the operation of relays AW and AX. The digit switch is then stepped to position 3 on the release of relay DS where a circuit is closed over contacts *b*8, *rs*5, *vf*1, *ds*3, *ax*3, *aw*2 and *ay*6 for relay LC. The relay operates and locks up over contact *lc*1. Contact *lc*2 closes a stepping circuit for switch SD which steps to its 8th position in which the stepping circuit will be found open at contact *lc*3. Contact *lc*4 removes a short circuit from winding (III) of relay SS, contact *lc*5 closes an operating circuit over wiper SD4 in position 8 for relay ST and contacts *lc*6, *lc*7 and *lc*8 prepare circuits for winding (II) of relay FD which are completed over cross connections to marking terminals 11 to 20 as required for cutting out some of the condensers and shunting a resistance across the condensers which have been cut out to increase the rate of impulsing. The second code digit is received on the B register and the distributor is stepped to position 4 but as contacts *aw*3 and *ax*3 in the circuit over wiper DD8 are both open relay TC is not operated. Following the operation of relay ST the out-sending circuit is closed and the first digit "0" is transmitted over wipers SD7, SD3 and wires W and X and after this digit has been received by the 1st trunk selector relay TS is released and relay DC is operated. At contact *dc*1 a circuit is closed for stepping switch SD to position 10. In position 10 the 2nd digit is transmitted untranslated by the closure of one or more of the contacts *bw*4, *bx*6, *by*7, *bz*7 and the 1st local selector is set. Switch SD then steps to position 11 whereupon relay SS operates over its winding (III) and locks up over its winding (II) and contact *ss*6. Contact *ss*5 short circuits winding (III) of relay SS and the magnet SDM operates and by itself release steps the controller to position 12. Relay SS prepares the circuits for impulsing and relay FD operates over wiper SD4 and contact *rm*2 to prepare for fast impulse transmission. As, however, in the call under consideration only two digits are necessary the operator depresses the "finish" key and relay F operates over its winding (II) and wiper 7 of the coupling switch. The following circuit is then completed; earth over contacts *rs*3, *b*7, *rl*1, *co*5, *so*3, wiper SD8, 4th contact and wiper DD7, contacts *rm*6, *f*2, *sy*7, *cn*2, relay CO to battery. Relay CO operates and contact *co*7 connects battery over a resistance to wire Y to switch in a bridge in the 1st local selector. Release of the register sender takes place as before described.

If the call is to be set up wholly by automatic selecting switches further digits up to 7 in all are keyed and these are registered on the C, D, E, F, G registers or as many of them as may be necessary. In this case relay F will not be operated after the 2nd digit has been registered. Relay FD is operated in position 12 of the controller and may lock up over its winding (II) if the cross connections permit to cut out one or more of the condensers from the circuit of the right hand winding of relay A to increase the speed of impulse transmission. Following the operation of the relays of the C register one of the contacts *cw*7, *cx*7, *cy*4, *cz*4 will be closed and relay S will be operated. Contact *s*2 extends earth to relay SN and this relay operates and at contact *sn*1 closes the circuit of relay A. Contact *sn*2 operates relays DQ and X and contact *sn*3 prepares a locking circuit for the counting

relays. Contacts of relay SS disconnect wipers SD7, SD3, SD2 and SD6 from the wires W, X, Y and Z and connect them to relay SZ and connect wires W and X in a loop impulsing circuit including contact *ar*1 and contact *vf*3 in its back position. Relay A commences to generate impulses and these are repeated at contact *a*2 for the operation of the relays of the counting chain. At each release of relay A the circuit of relays AR and AS are operated. The operation of this latter relay is ineffective as contact *vf*2 in the circuit over contact *as*1 and wire Y is open. Operation of relay AR causes contact *ar*1 to change over to transmit an impulse break in the loop over wires W and X and the subsequent release of relay A causes the loop to be closed again consequent on the falling back of contact *ar*1 by the release of relay AR at contact *a*1. DC loop impulses are transmitted in this manner until relay SZ is operated but no voice frequency current impulses are transmitted. The operated relays of the C register connect earth over their locking contacts 1 and wipers SD6, SD2, SD3, and SD7, and contacts *s*4, *s*5, and *s*6 to contacts *ca*3, *cb*5, *cc*5 and *cd*4 and when the relays corresponding to the number of impulses to be transmitted have been operated relay SZ operates to terminate impulsing. Relay SR operates, releases relay SN which releases relay DQ and a circuit is closed over contacts *b*8, *sr*6, *dq*2 and *dp*1 for relay DP. Relay DP operates and locks up and at contact *dp*3 re-operates relay SN and the counting relay chain is started into operation to measure off the inter-train pause. A train of 8 impulses is measured off, this being represented by the operation and locking of relays CD, CC and CA. Relay AD has not been operated so that on the 3rd operation of relay CA a circuit is closed over contacts *do*2, *ad*6, *cc*6 and *ca*4 for relay VC. Relay VC operates and locks up, releases relay SN at contact *vc*3, relays SZ and SR at contact *vc*2 and holds relay DP by means of its winding (II) over contacts *sr*2, *vc*4 and magnet SDM. It may here be remarked that relay SR is held over its winding (II), contacts *sr*1 and *f*3, wipers DD6 and SD8 until the next digit has been registered. When this registration has taken place the distributor is stepped on and the locking circuit of relay SR is interrupted and the relay released. Magnet SDM then operates and the controller is stepped to position 13 in which the locking contacts of the D register relays are connected over wipers SD6, SD2, SD3, SD7. The 5th, 6th and 7th digits are registered and are transmitted in positions 14, 15, and 16 of the controller after which the distributor will rest in position 9 and the controller will be held in position 16. The operator then depresses the "finish" key operating relay F which at contact *f*3 releases relay SR to allow the controller to step to position 17. In this position of the controller and the 9th position of the distributor earth will be extended over wipers SD8 and DD7 to relay CO which operates and brings about the release of the register sender. If there is no bridge in the automatic switch circuits the inter-train pause may be shortened and made dependent on the operation of the switching relay at a selecting switch. The arrangements are as follows: When relay SZ operates contact *sz*3 bridges relay VA across the impulsing loop. The relay operates in series with the distant impulse receiving relay and at contact *va*1 connects condenser QB in a charging circuit in which it is rapidly charged. When the distant selector switching relay operates the circuit of relay VA is momentarily interrupted and relay VA releases. The condenser QB discharges over contact *va*1 and relay VB operates and locks up over contacts *vb*1 and *sr*5, relay SR having been operated on the closure of contact *sz*1. Contact *vb*1 closes a circuit for relay VC which operates and locks over contact *vc*1 and releases relay SN with the aforementioned result that provided the next digit has been registered the controller is stepped and the impulsing circuit re-prepared.

If the 1st trunk selector encounters congestion relay RL will be operated in the manner described under the heading "Main trunk calls" but this operation will take place in position 9 of the controller after it has stepped following the release of relay TS and operation of relay DC after the first digit has been transmitted. The controller will be stepped slowly round until position 8 is reached whereupon relay RM is operated over wipers SD4 and *lc*5 and relays RL and DC released. Relay LC is locked up so there will be no self stepping circuit for magnet SDM in this position. Relay ST re-operates and the first digit is repeated. If this is accepted other digits follow and relay RM is released by differential action in position 12 of switch SD. If congestion is still encountered relay CN operates with the result previously described.

If the local 1st selector encounters congestion a similar action occurs, relay RL being operated in position 11 and the controller being stepped slowly round until position 8 is reached. The 1st trunk selector having been restored to normal consequent on the earthing of wiper 5 of the coupling switch at contact *rl*6 the first digit is re-transmitted and a further attempt made to set up the connection. Depending on the condition now met with by the local 1st selector relay RM is released or relay CN is operated and the call either proceeds or the register sender is released.

*General*

By the operator of the "cancel" key a connection may be released at any time. The depression of this key applies earth over the wire connected to the bank of wiper 14 of the coupling switch and this earth is extended over contact *c*1 to relay CO. Relay CO operates and at contact *co*2 applies earth to wiper 11 of the coupling switch the effect of which is to disconnect battery in the position circuit from the wire connected in the bank of wiper 13 of the coupling switch thus releasing relay TA. The remainder of the releasing operations take place in the manner described under the heading "Main trunk calls."

When the register sender is taken into use relay BA is operated and contact *ba*7 connects the right hand winding of relay ZS to a wire SP which is earthed periodically. When earth is applied to wire SP relay ZS operates and locks up over its left hand winding and contacts *zs*1 and *b*8 and at contact *zs*2 connects relay CO to the wire ZP. Contact *zs*3 connects earth to a wire for starting up the forced release device by means of which wire ZP is earthed. Wire ZP is earthed at a prescribed interval after the earthing of relay SP and when this interval expires relay CO is operated bringing about the forced release of the register sender.

Each time the circuit for a motor uniselector is closed relay RA operates. Contact *ra*1 transmits a signal to a delayed alarm device, contact *ra*2 flashes the lamp PL and contact *ra*3 prevents

re-operation of relay C while this condition exists. Contact *co8*, *co4*, and *co3* perform functions similar to those performed by contacts of relay RA with the exception that lamp PL is flickered instead of being flashed.

By removing the link from the upper and middle springs of jack TJ and placing it between the middle and lower springs the register sender can be put out of service and disconnected from the chain start circuit. The effect is to release relay C and to cause lamp PL to glow steadily.

I claim:

1. In a telephone system, a register sender, means in said register sender for transmitting impulses of direct current, means in said register sender for transmitting impulses of voice frequency current, and means in said register sender for determining whether said direct current impulses or said voice frequency current impulses shall be transmitted.

2. In a telephone system, a register sender having means for transmitting impulses of direct current and, at the same time each of said direct current impulses is transmitted, transmitting an impulse of voice frequency current.

3. In an automatic telephone system wherein apparatus adapted to respond to voice frequency current impulses has means for suppressing direct current impulses transmitted thereto, a register sender for controlling said apparatus, said register sender having means for transmitting a train of direct current impulses to said apparatus and, concurrently, transmitting thereto a corresponding train of voice frequency current impulses.

4. In an automatic telephone system wherein apparatus adapted to respond to direct current impulses has means for suppressing voice frequency current impulses transmitted thereto, a register sender for controlling said apparatus, said register sender having means for transmitting a train of voice frequency current impulses to said apparatus and, concurrently, transmitting thereto a corresponding train of direct current impulses.

5. In an automatic telephone system wherein calls from a local exchange to a distant exchange may be extended over a direct route or an alternative route, said alternative route including a tandem exchange, a register sender for controlling the extension of calls over both routes, and means in said register sender for transmitting impulses of voice frequency current to operate switching equipment in said tandem exchange whenever a call is extended over said alternative route.

6. In a telephone system as claimed in claim 5, wherein, after a connection has been completed to said tandem exchange from said local exchange during the extension of a call over said alternative route, a voice frequency current signal is reverted to said local exchange over said connection if said switching equipment in said tandem exchange is unable to further extend said connection along the alternative route, means in said register sender responsive to said reverted signal for causing said connection to said tandem exchange to be released and for rerouting said call.

7. In an automatic telephone system wherein the extension of calls from a local exchange to a distant exchange is controlled by a code characterizing the distant exchange, and wherein such calls may be extended to the distant exchange over any of a plurality of routes, means for translating said code characterizing the distant exchange into any one of a plurality of routing codes each corresponding to a different one of said routes, means for transmitting said one routing code to control switches in said local exchange to extend a connection from said local exchange by way of the route corresponding to said one routing code, and means controlled at times by said translating means for transmitting voice frequency current impulses over the connection extended from the local exchange.

8. In a telephone system having automatic switches, a plurality of code conductors, a register sender, means in said register sender for marking said conductors variably to operate one of said switches to extend a connection to another of said switches, and means in said sender for then transmitting a train of impulses over certain of said code conductors to operate said other switch to further extend said connections.

9. In an automatic telephone system wherein call directing digits are transmitted to a register sender, and wherein said register sender thereafter controls automatic switches to extend said call in accordance with said digits, means in said register sender for transmitting either impulses of direct current or impulses of voice frequency current to control said switches, and means for determining from the call directing digits transmitted to said register sender which of said two types of impulses shall be transmitted.

10. An automatic telephone system as claimed in claim 9 wherein, if calls over any path to which the switches under control of said register sender have access are subject to delay due to congestion of that path, the register sender is marked in accordance with the probable length of said delay, and wherein said register sender has means effective, responsive to the receipt of the digits for directing a call over a congested path, to transmit a signal depending upon the probable length of delay to which said call will be subject.

11. In a telephone system, a register sender having a plurality of control conductors outgoing therefrom, means in said register sender for transmitting voice frequency current impulses over a circuit including two of said conductors in series, and means in said register sender for transmitting direct current impulses over a circuit including not more than one of said conductors.

12. In a telephone system wherein the operation of an automatic switch is controlled by a register sender associated with said switch, said register sender thereafter being released, and wherein said register may then be again associated with said automatic switch before said switch is released and caused to register one or more digits, means in said register sender controlled by said registered digits for transmitting to said switch impulses of voice frequency current dependent upon said digits.

BERNARD ANTHONY HENSLER.