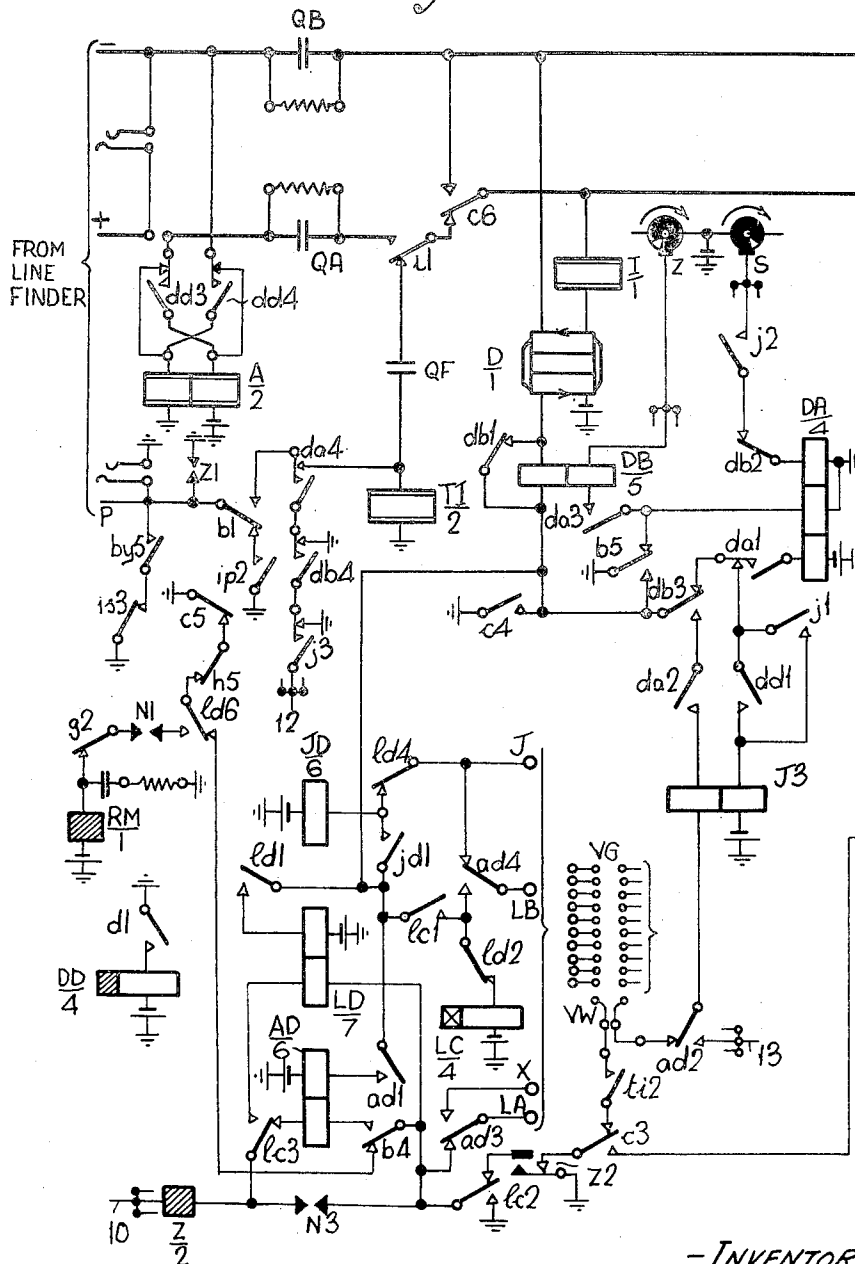


2,154,776

Filed Nov. 4, 1936

10 Sheets-Sheet 1

Fig. 1.



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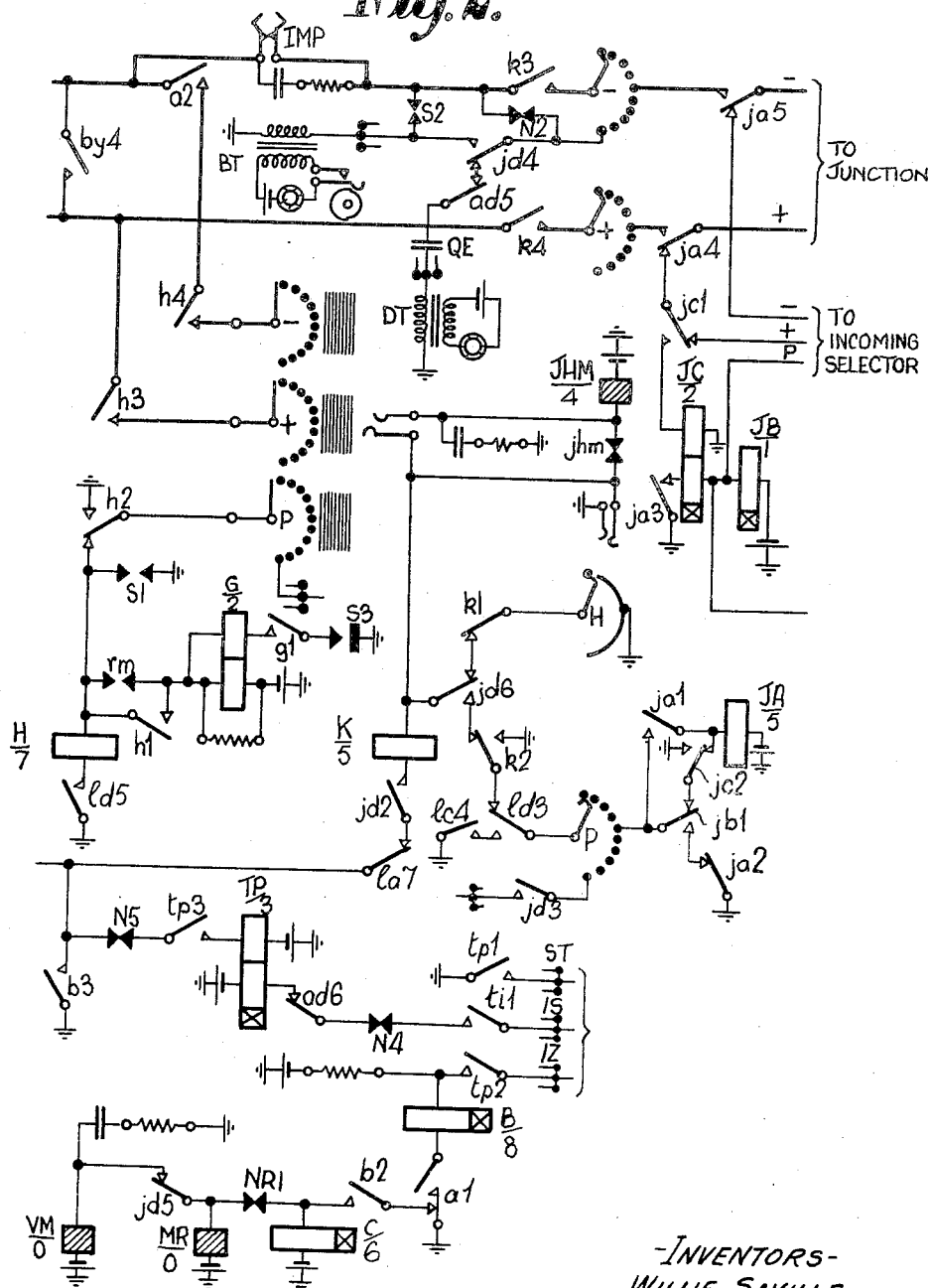
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TELEPHONE SYSTEM

Filed Nov. 4, 1936

10 Sheets-Sheet 2

Fig. 2.



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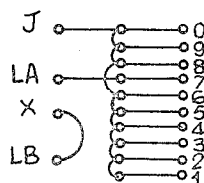
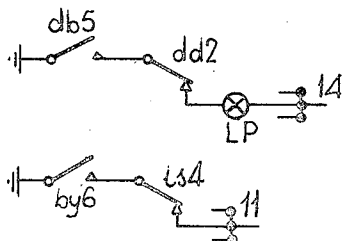
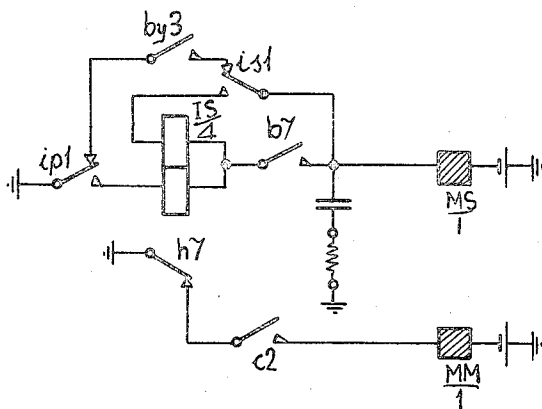
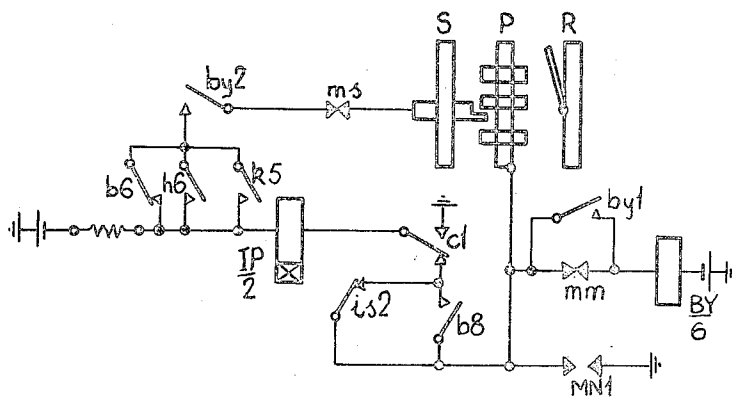
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10 Sheets-Sheet 3

Fig. 3.



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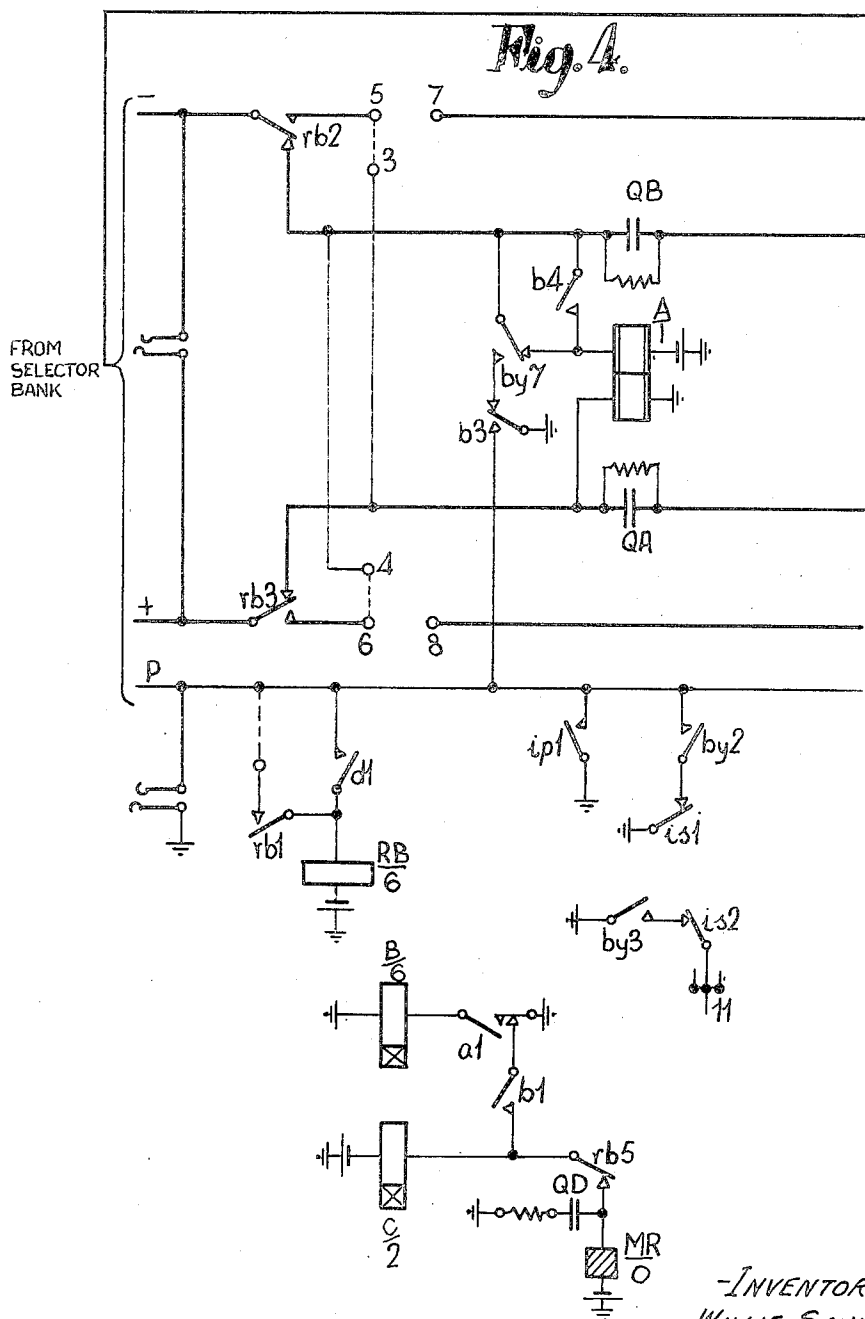
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2,154,776

TELEPHONE SYSTEM

Filed Nov. 4, 1936

10 Sheets-Sheet 4



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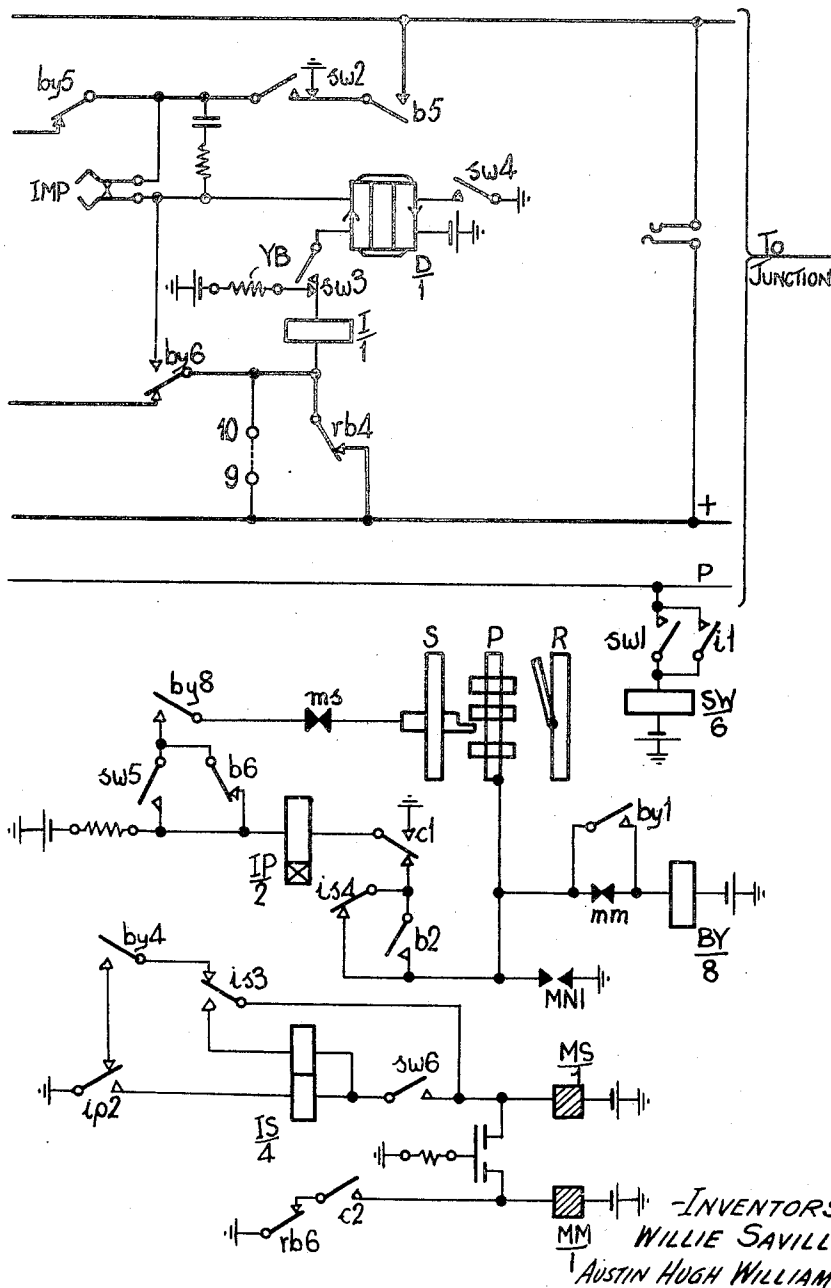
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TELEPHONE SYSTEM

Filed Nov. 4, 1936

10 Sheets-Sheet 5

Fig. 5.



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TELEPHONE SYSTEM

2,154,776

Filed Nov. 4, 1936

10 Sheets-Sheet 6

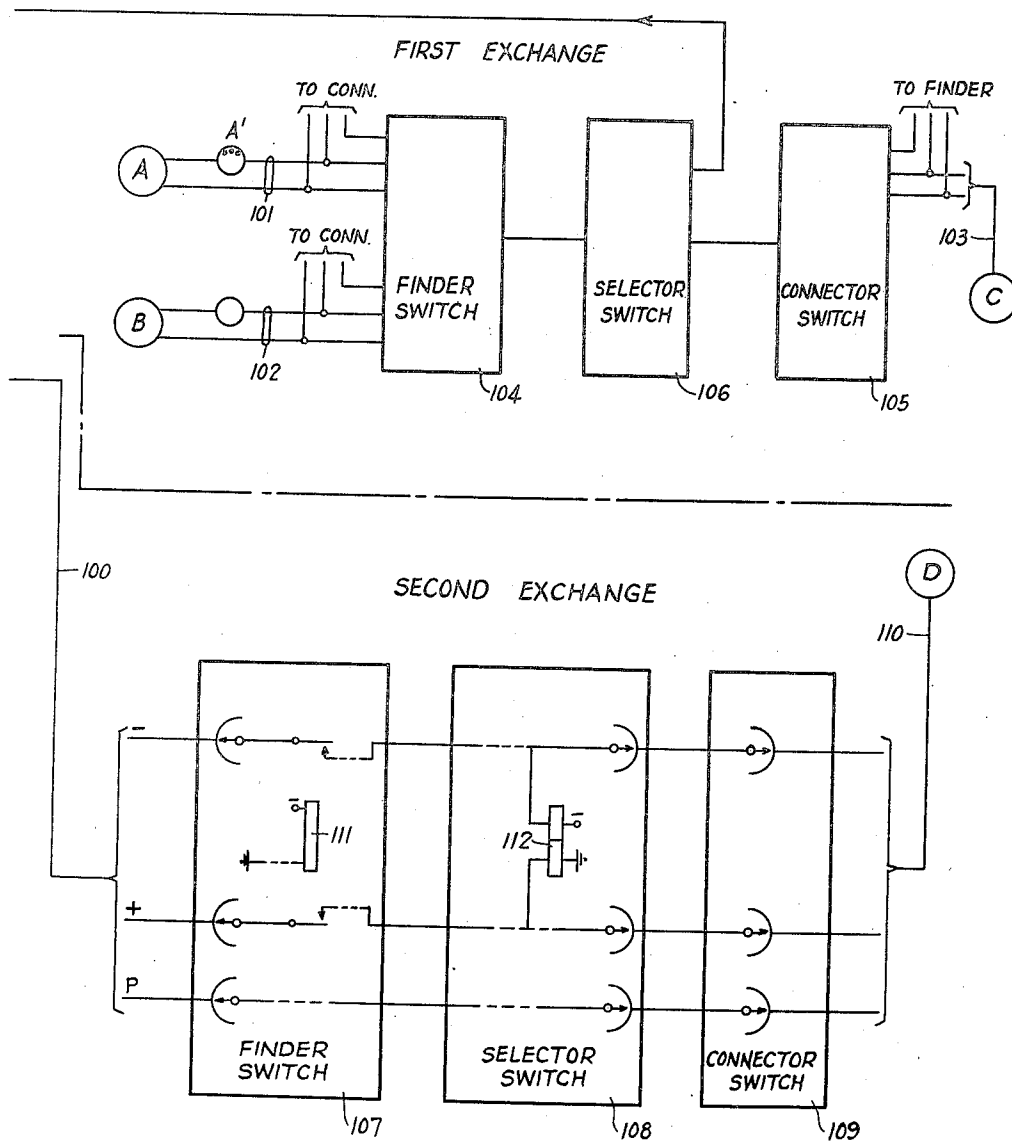


Fig. 5a

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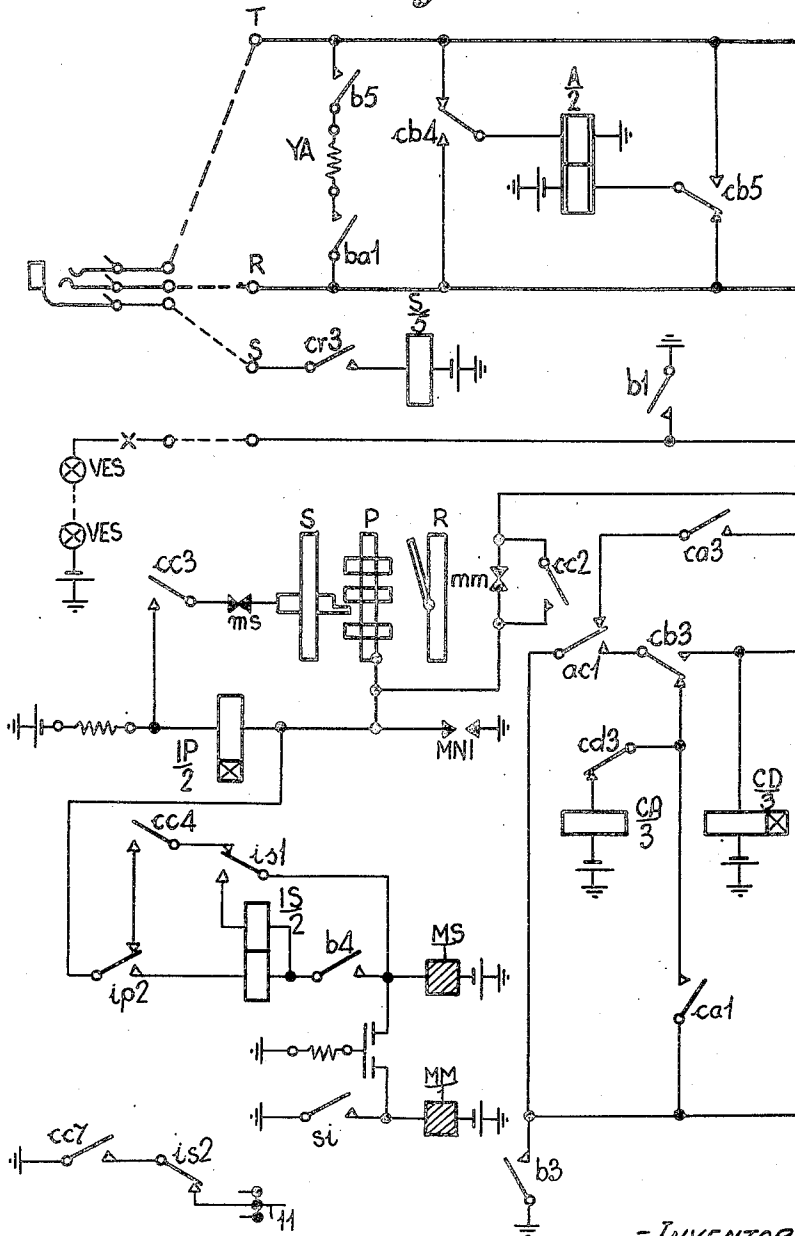
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TELEPHONE SYSTEM

Filed Nov. 4, 1936

10 Sheets-Sheet 7

Fig. 6.



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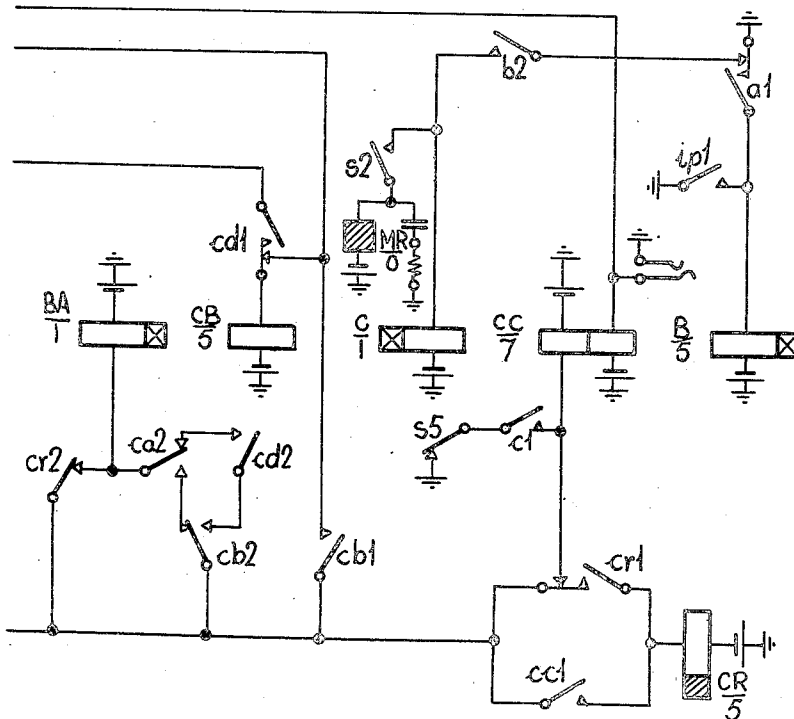
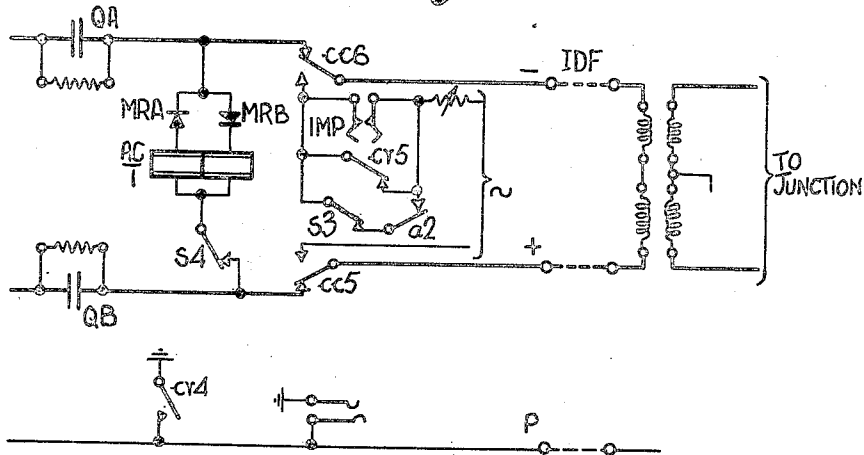
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TELEPHONE SYSTEM

Filed Nov. 4, 1936

10 Sheets-Sheet 8

Fig. 7.



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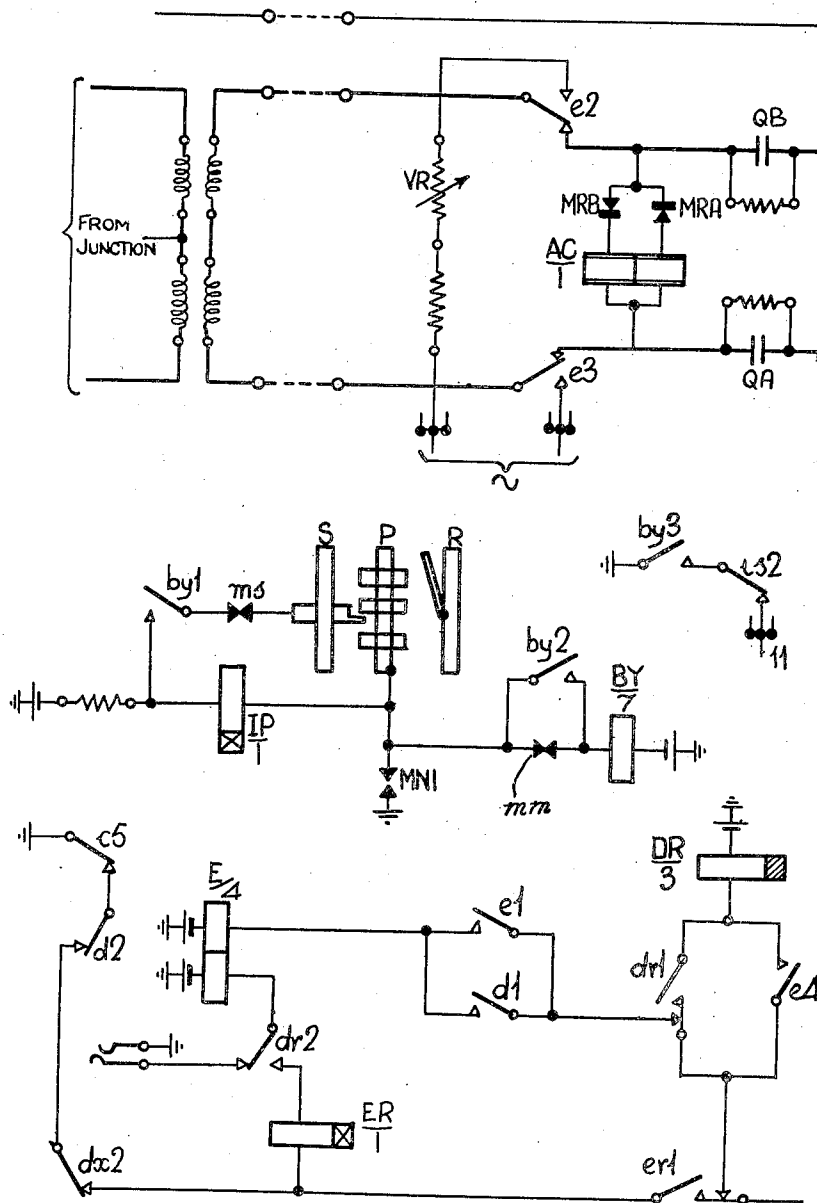
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TELEPHONE SYSTEM

Filed Nov. 4, 1936

10 Sheets-Sheet 9

Fig. 8.



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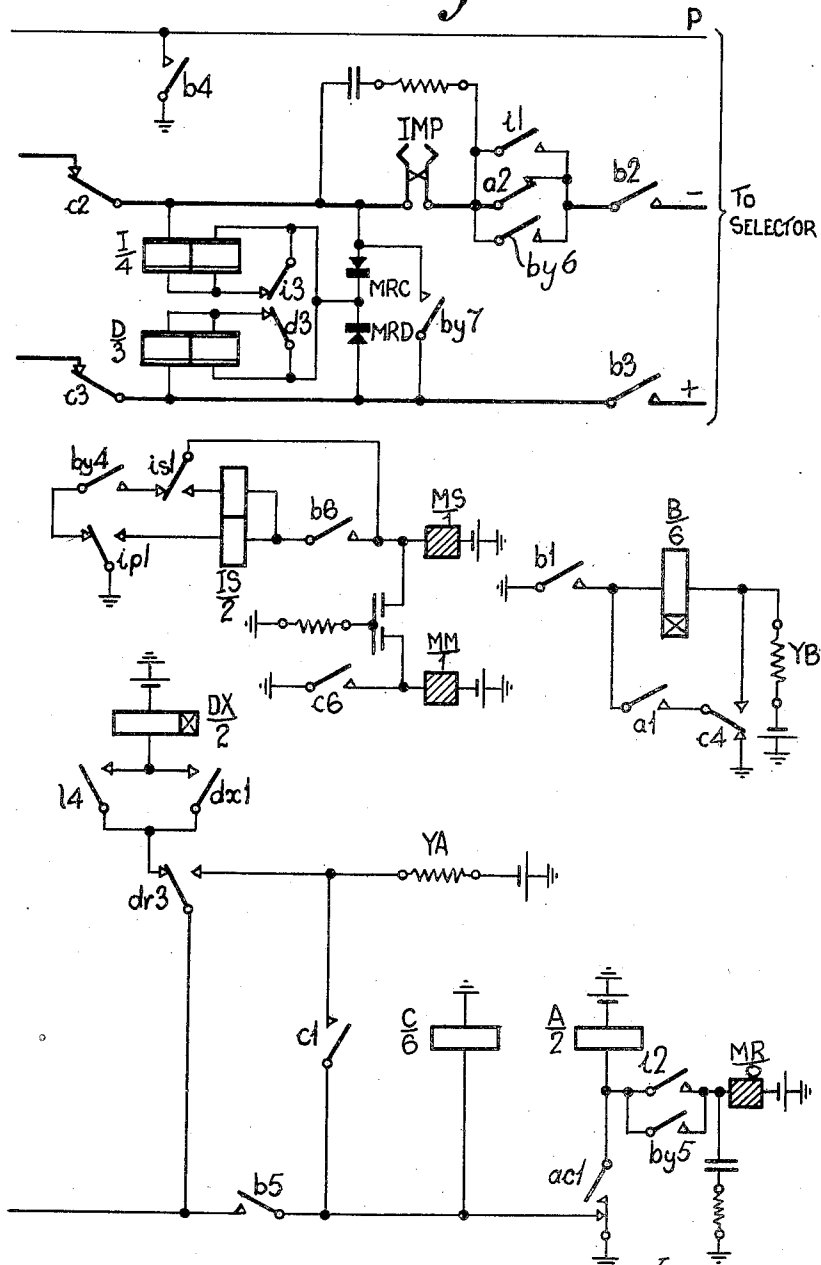
W. SAVILLE ET AL
TELEPHONE SYSTEM

2,154,776

Filed Nov. 4, 1936

10 Sheets-Sheet 10

Fig. 9.



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UNITED STATES PATENT OFFICE

2,154,776

TELEPHONE SYSTEM

Willie Saville and Austin Hugh Williams, Liverpool, England, assignors to Associated Telephone and Telegraph Company, Chicago, Ill., a corporation of Delaware

Application November 4, 1936, Serial No. 109,072
In Great Britain December 16, 1935

22 Claims. (Cl. 179—18)

The present invention relates to automatic telephone or like systems and is more particularly concerned with the provision of improved systems in which certain or all of the impulse series characterizing the setting digits are stored on a simple regenerating device, and retransmitted after a delay dependent upon the nature of the switching operations to be performed preparatory to their despatch. Although this facility is particularly suited in telephone systems to the realization of junction economy it will be appreciated that its utility is not limited to this application.

According to one feature of the invention in a discriminating selector repeater adapted to employ a regenerating device an outgoing junction to the main exchange is seized only after the dialling of main office discriminating digits thereby reducing the holding time of the said junction.

According to another feature of the invention a regenerating device is provided at the outgoing end of a junction terminating at the distant end in a finder switch bank, the usual inter-digital pause limitations being overcome by arranging to store the digits dialled until the distant equipment is ready to receive them, thus reducing the equipment required at the distant exchange.

According to a further feature of the invention in systems utilizing commercial frequency alternating current dialling a regenerating device is inserted at each end of the junction thereby enabling the alternating current impulses to be sent at a speed most suited to the frequency employed, while the arrangement gives a substantial and reliable increase in the junction dialling limits.

The invention will be better understood from the following description of several methods of carrying it into effect, reference being had to the accompanying drawings comprising Figs. 1 to 9. Of these, Figs. 1-3 show a discriminating selector repeater in which junction economy is obtained by arranging that a junction to the main exchange is not taken into use until after the reception of a discriminating digit which indicates that such is required; Figs. 4, 5 and 5a show an outgoing repeater arranged to store and hold the received digits until a finder switch at the distant exchange signals that it has found the calling junction; and Figs. 6 and 7 and 8 and 9 show respectively outgoing and incoming A. C. dialling repeaters for use at opposite ends of a line by which D. C. impulses are received and

transformed into A. C. impulses for transmission over the junction and then reconverted into D. C. pulses to control the operation of the automatic switches at the distant exchange.

In each case it is assumed that use has been made of a mechanical impulse repeater or regenerator of the type disclosed in application Serial No. 79,830, J. W. McClew and C. R. Woodward, filed May 15, 1936, and entitled Mechanical impulse repeaters, which in addition to repeating the impulses in corrected form also provides a controlled delay between their reception and subsequent retransmission which is essential to the operation of the system. It will be understood however that the invention is not limited to a regenerating device of this precise construction and that the use of any form of impulse registering device which functions to store a plurality of series of impulses and is thereafter effective to repeat the impulses is contemplated.

Referring now to Figs. 1-3, when the discriminating selector repeater is taken into use for instance over a finder switch, the loop extended from the calling subscriber over the incoming negative and positive conductors operates relay A which at armature *a1* operates relay B. A guarding and holding earth is then fed back by way of the low resistance winding of relay TI and armatures *da4* and *b1* to the P conductor and a number of other circuits are prepared. Relay TI is operated in series with the holding relay in the finder. Dial tone is extended to the subscriber from the earthed dial tone transformer DT by way of condenser QE and the negative conductor.

On reception of dial tone the subscriber dials the first digit and relay A responds. Each time this relay releases a circuit is completed by way of armatures *a1* and *b2* to energise relay C, the vertical magnet VM and the receiving magnet MR of the mechanical impulse repeater which for brevity will hereafter be termed a regenerator. Relays B and C are maintained operated during the impulse train due to their slugs. Relay C upon operating, at armature *c1* completes a circuit for relay IP and at armature *c2* energises the regenerator marking magnet MM. Armature *ip1* thereupon operates relay IS in series with the regenerator sending magnet MS, the magnet being non-operative in this condition. It should be explained that the regenerator comprises essentially a receiving ratchet wheel R which is rotated step by step under control of the magnet MR and which is arranged on one side of a fixed disc P carrying round its periph-

ery a circle of 40 pins. The rotation of the receiving disc R stores up energy in a clock-spring to drive the sending disc S and thus actuate the impulse springs IMP and send out regenerated impulses of the correct character. Before the first digit is received the armature of the marking magnet MM is resting against a pin in the disc P which it has pushed forward to restrain the sending disc S. During the first digit the energization of the marking magnet upon the operation of relay C tilts a lever carried by the receiving disc R until it is clear of the pins. At the end of the digit the receiving disc will have been advanced a number of steps equal to the number of impulses in the train and on the release of relay C after a short interval, the marking magnet MM will be de-energised and thus allows the lever carried by the receiving disc R to tilt back towards the disc P thereby displacing a corresponding pin into the path of the disc S thus storing the digit dialled. Hence if the successive digits dialled are 5, 4 and 7, pins 5, 9 and 16 counting from the original resting position are displaced. It should be noted that the sending disc S is at present restrained by the pin which was displaced at the end of the previous call. When the receiving disc R is first moved off normal, the off-normal springs MN1 close and thus when the marking magnet is restored at the end of the first digit the springs mm controlled by this magnet close and a circuit is completed for relay BY which subsequently locks by way of armature by1.

By this time the vertical magnet will have raised the wipers to the desired level and if the digit dialled is other than 7 thus indicating that the call is to be extended via the main exchange, a circuit will be completed from earth, release magnet springs Z2, armatures c3 and ti2, vertical wiper VW and bank VB, cross connection to the terminal J, armature ld4, winding of relay JD to battery. The cross connections of the vertical bank suitable for the circumstances to be described, are shown in the lower right-hand corner of Fig. 3. Relay JD upon operating locks to earth by way of armatures jd1 and b5, at armature jd5 disconnects the vertical magnet from the impulse circuit to prevent its further operation, at armature jd6 completes a driving circuit for the junction hunter magnet JHM and at armature jd2 completes a circuit for the switching relay K. If the wipers of the junction hunter are standing on an engaged outlet, earth will be returned over the P wiper and armatures ld3, k2 and jd6 to short-circuit relay K and operate the magnet JHM. The magnet operates its interrupter springs jhm which thereupon open the energizing circuit and since the magnet is of the reverse drive type the wipers are stepped to the next outlet. The switch will continue to hunt in search of a free outlet and if all outlets are engaged it will rotate to the last position which is not multiplied whereupon the P wiper will no longer encounter earth. Relay K now operates in series with the magnet which is non-operative in this condition and busy tone will be returned to the subscriber over the negative line by way of the earthed busy tone transformer BT, armature jd4, the junction hunter, negative bank and wiper, armature k3 and the impulse springs IMP. If a free outlet is encountered as indicated by absence of earth potential, relay K will be operated as above but busy tone cannot be connected to the line since the switch is not in the last position.

Assuming a free outlet is found so that the call can proceed, relay K at armature k2 applies a guard earth to the P wiper thereby operating relay JA associated with the junction seized which disconnects the local incoming selector. A loop is now extended forward over the junction to prepare the switch at the distant exchange for operation, this loop including armature by4, the regenerator impulse springs IMP, armatures k3 and k4, the negative and positive junction hunter wipers and armatures ja3 and ja4. In addition armature k5 completes a circuit from earth, off-normal springs MN1, fixed disc P which is in contact with the pin left projecting from the previous call, the reset pin in the disc S which gears against the displaced pin, springs ms, armatures by2 and k5 to short-circuit relay IP. After a short interval relay IP releases and at armature ip1 disconnects relay IS which holds operated for a further short period due to its short-circuited upper winding. On the release of relay IS a circuit is completed from earth, armatures ip1, by3 and is1 to energise the sending magnet MS which now pushes the reset pin in the disc S to the right in order to restore the displaced pin in the disc P against which it is resting. On operation of the magnet MS the springs ms open and thus remove the short-circuit from relay IP which immediately re-operates and at armature ip1 re-operates relay IS and de-energises the magnet MS.

As described in the prior specification the reset pin is now withdrawn, thus releasing the sending disc S which rotates until it comes up against the stop pin displaced at the end of the first digit. During this rotation a fresh set of impulses corresponding in number to those received but correct as regards ratio and speed is generated at the springs IMP controlled from the regenerator and these impulses serve to set the switches at the distant exchange. When the reset pin in the disc S comes up against the displaced stop pin indicating the termination of the first series of impulses, relay IP is again short-circuited and in turn releases relay IS to produce another momentary operation of the sending magnet MS. Accordingly the disc S is again released to generate a second series of impulses in the manner described. It will be appreciated that the reception and retransmission of impulses goes on simultaneously but that the two operations are independent of each other and that the sequential release of relays IP and IS in each case provides the necessary pause between successive series of impulses.

When all digits have been received and retransmitted the sending disc S will catch up with the receiving disc R, whereupon the off normal springs MN1 open and relays BY, IP and IS are finally released.

When the connection is completed and the called subscriber replies, battery is reversed over the called side of the circuit to operate the shunt field relay D which at armature d1 operates its relief relay DD. Relay DD upon operating, at armatures dd3 and dd4 repeats the battery reversal to the calling side of the circuit and at armature dd1 operates relay J over its right-hand winding. Armature j1 thereupon completes a locking circuit for relay J independent of armature dd1 and armature j2 completes a starting circuit for the meter delay relays DA and DB which are operated from a so-called S and Z pulse cam which is arranged to supply to two corresponding leads battery pulses with a definite

time relation between them. On the occurrence of the next S pulse, relay DA is operated over its upper winding and at armature *da3* prepares a circuit for relay DB which operates after an appropriate time interval from the Z pulse in series with the middle winding of relay DA. Relay DA remains locked over its lower winding until relay DB operates, when both the initial energising circuit and the locking circuit for relay DA are opened but it is held over its middle winding in series with the right-hand winding of relay DB for the duration of the Z pulse. Relay DA also at armature *da1* disconnects the locking circuit of relay J which thereupon released while on the operation of relay DB an earth was extended by way of the left-hand winding of relay J to the right-hand vertical wiper VW. During the application of the Z pulse, since relays DA and DB are operated, relay J will be operated a number of times depending on the zone connected with, the necessary discrimination being effected by the level to which the vertical wiper has been stepped. Booster battery pulses by way of conductor 12, armatures *ja3*, *db4*, *da4* and *bl* are extended on to the release trunk conductor P to actuate the subscriber's meter in the usual manner. At the end of the Z pulse, relay DA restores to prevent further operation of the metering relay J while relay DB remains operated over its left-hand winding in series with the polarising winding of relay D.

On the release of the connection at the end of the conversation, relay A releases when the calling subscriber hangs up and disconnects relay B which releases after a short period. During the release time of relay B, relay C is operated momentarily and at armature *cl* operates relay IP. When relay B releases, relay C will hold operated for a short interval and during this time earth will be extended over armatures *ip2* and *bl* to the release trunk. On the release of relay C a circuit is completed from earth, armatures *c5*, *h5*, *ld6*, *b4* and off-normal springs N3 to energise the release magnet Z by way of 45 equipment connected to common conductor 10 which gives a delayed alarm in case of failure to release and the switch wipers are thereupon restored to normal. A guarding earth is applied to the release trunk conductor during the release by way of springs *z1* in case relay IP should release during this time and a locking circuit is completed for the release magnet from earth, springs *z2*, armature *lc2* and springs N3 in order to ensure that the switch will be properly released in case the subscriber should again lift off his receiver before the switch had restored to normal. When the switch fully restores, the off-normal springs N3 open the release magnet circuit. Relay C upon releasing also opens the holding circuit for relays K and JD and on the release of relay K armature *k2* releases relay JA which at armature *ja3* opens the circuit of relays JC and JB. The junction guard relays JA and JB provide a guarding overlap to prevent the junction being again seized before the distant switches are released, the conditions being such that on normal junction calls relays B, C, K, JA and JB release in succession before the junction is freed while in the main exchange incoming switch only two slow relays release to free the switch. During this time it will be seen that an earth is applied to the junction hunter P bank by way of armatures *ja2* and *jb1* while on release of relay JB the earth will be removed

and relay JA substituted to indicate the free condition.

In case the calling subscriber should release the connection prematurely, the release conditions are slightly different since it is desirable to secure immediate release of the train of switches so far set up and thereafter to guard the discriminating selector repeater against further seizure until the regenerator is fully restored to normal. Relay A upon releasing releases relay B while during the momentary operation of relay C relay IP is operated from armature *cl* and relay IP thereupon at armature *ip2* extends an earth to guard the P lead and at armature *ip1* operates relay IS while relay B holds up. On the release of relay B, relay IS remains locked up over its two windings in series and when relay C subsequently releases, relay IP falls away and at the same time relay K is restored to open the loop circuit and thus release the train of switches set up in the distant exchange. Relay IP upon releasing removes the earth from the P conductor to release the preceding switches and at the same time disconnects relay IS. This relay releases quickly since its upper winding is not now short-circuited and at armature *is3* replaces the guard earth on the P conductor since relay BY will be still operated owing to the off-normal condition of the regenerator. The regenerator therefore continues to retransmit its stored digits into an open circuit and when all are delivered, the off-normal springs MN1 open to release relay BY which thereupon at armature *by5* removes earth from the P conductor to free the switch for further use. In order to speed up the disposal of the stored digits in this condition, relay IS is maintained normal since relay B has released and a shortened pause represented by the release time of relay IP only is provided between the digits.

Certain calls completed over the main exchange but still in the single fee area are designated by 7 as the first digit. On the completion of the dialling of this digit, relay C releases after its slow period whereupon a circuit is completed from earth, springs *z2*, armatures *c3* and *ti2*, left-hand vertical wiper VW, vertical bank VB cross connection to terminal LA, armature *ad3* and springs N3 to operate the release magnet Z. The release magnet is thereafter locked in a local circuit as before by way of springs *z2*, armature *lc2* and springs N3 while the switch is restoring to normal. The off-normal springs N3 open when the wipers are fully restored and remove the short-circuit from relay AD which thereupon operates over its high resistance lower windings in series with the release magnet. The light armature *ad1* is arranged to make first and then completes a circuit to operate relay AD fully by way of its upper winding. Armature *ad5* disconnects the dial tone circuit, armatures *ad3* and *ad4* alter the connections to terminals LA and LB and armature *ad2* connects up the single fee meter pulse common which is connected over lead 13.

Upon reception of the second digit which will be other than 7, the switch will be again stepped and on the release of relay C after its slow period, relay JD is operated in the manner previously described thus causing a junction to the main exchange to be selected and thereafter further operations proceed as described previously.

Local calls are characterized by the initial digits 77. When the first digit 7 is dialled the switch releases and relay AD is operated on res-

toration of the switch to normal as just described while when 7 is dialled as a second digit, on release of relay C a circuit is completed from earth, springs *a2*, armatures *c3* and *ti2*, left-hand vertical wiper, cross connection to terminal *LA*, armature *ad3*, cross connections between the terminals *X* and *LB*, armatures *ad4* and *ld2*, winding of relay *LC* to battery. Relay *LC* thereupon locks by way of the light armature *lc1*, armature *lc2* energizes the release magnet *Z* to again restore the wipers to normal and armature *lc3* prepares an operating circuit for relay *LD*. When the switch reaches the normal position, the off-normal springs *N3* open and remove the short-circuit from the lower high resistance winding of relay *LD* which thereupon operates in series with the release magnet. Armature *ld1* provides a locking circuit, armature *ld2* disconnects relay *LC*, armatures *ld4* and *ld7* open points in the circuit for relays *JD* and *K* and armatures *ld5* and *ld6* prepare hunting circuits for the switch.

On the reception of the third digit the wipers are raised to the desired level and when relay *C* releases after the impulse train a circuit is completed from earth, armatures *c5*, *h5* and *ld6*, springs *N1* and armature *g2* to battery via the rotary magnet *RM* which energizes and thereupon advances the wipers into engagement with the first set of contacts in the level selected. The switch now acts as a selector and performs a hunting operation in search of a free outlet to a subsequent local switch. If the first outlet is engaged the *P* wiper will encounter an earth which will be extended by way of armature *h2* and the magnet interrupter springs *rm* to operate relay *G* over its lower winding. Armature *g2* thereupon disconnects the rotary magnet which de-energizes and springs *rm* open and release relay *G*. The magnet is then re-energized, the wipers are stepped to the next position and relay *G* re-tests. Should this and subsequent outlets be engaged relay *G* and the magnet *RM* will continue to interact to drive the switch until the *P* wiper fails to encounter an earth thus indicating a free outlet. The earth shunt is now removed from relay *H* and it operates from earth, armature *ld5*, winding of relay *H*, interrupter springs *rm*, lower winding of relay *G* (non-operative in this condition) to battery and at armature *h1* relay *H* locks independently of the springs *rm*. Armature *h2* applies a guarding earth to the *P* wiper, armatures *h3* and *h4* extend the impulse repeating loop comprising relays *D* and *I* and armature *a2* over the negative and positive wipers to the succeeding local switch, armature *h5* disconnects the circuit of the magnet *RM* which thereupon releases, and armature *h6* short-circuits relay *IP* to set the regenerator into operation and dispose of the first and second digits which are stored therein, these two digits being retransmitted into an open circuit as they are not required. The rotary off-normal springs *NR1* were operated on the first rotary step of the switch and open the impulse circuit to the regenerator receiving magnet *MR* and thus further impulses will be ineffective to operate this magnet but will be repeated by armature *a2* over the negative and positive wipers to set up the train of succeeding local switches. Relay *C* holds operated during each impulse train and at armature *c6* short-circuits relays *D* and *I* to provide an impedance-free impulse loop.

In case all the outlets in the level prove busy, the wipers are rotated to the 11th position where cam springs *S* are operated. Springs *S3* lock re-

lay *G* over its two windings in series thus holding open the rotary magnet circuit, springs *S1* extend an earth to the *P* wiper to operate the overflow meter and springs *S2* connect the busy tone transformer *BT* to the negative conductor by way of springs *IMP* thus returning busy tone to the calling subscriber to inform him that the connection desired is unavailable. The calling subscriber subsequently replaces his receiver to release the connection thereby releasing relays *A* and *B*. Since neither relay *K* nor relay *H* has been operated relay *B* at armature *b6* extends an earth from the off-normal springs *MN1* to short-circuit relay *IP* which releases and in turn releases relay *IS* thus initiating the operation of the regenerator to dispose of the first and second stored digits.

Calls originated from coin box subscribers are characterised by the extension of a tone over the release trunk conductor *P* which finds a circuit by way of armatures *b1* and *da4*, condenser *QF*, armatures *i1* and *c6* to the lower speaking conductor to inform the operator of the class of the calling subscriber. The high impedance relay *TI* connected in series with the guarding earth prevents any appreciable leakage of the discriminating tone.

In the case of faults such as permanent grounds by means of which the switch is taken into use but dialling is not proceeded with, an operation of relay *TI* in the normal manner the lower winding of relay *TP* is connected to a common lead *IS* extending to a delay set. Should this delay set not be in use this lead will be connected to earth which will operate relay *TP* over its lower winding. Armature *tp3* thereupon completes a circuit to lock this relay over its upper winding to earth by way of armature *b3*, armature *tp2* connects the *IZ* lead to the winding of relay *B* while armature *tp1* applies earth to the *ST* lead to start up the delay set mechanism. After a predetermined interval which may be conveniently of the order of 30 seconds, if the switch has not yet stepped off-normal and operated the off-normal springs *N4* and *N5* thus disconnecting the windings of relay *TP*, an earth will be connected to the *IZ* lead and will short-circuit relay *B* and initiate the forcible release of the connection. It will be understood that the subscribers' line circuits are preferably of the type which lock up under forced release conditions so as to prevent the taking into use of exchange switches until the fault is cleared.

Incoming calls over the junction are extended by way of armatures *ja4*, *ja5* and *jcl* to an incoming first selector which when taken into use connects earth to the *P* conductor to operate relay *JB* which thereupon at armature *jb1* applies earth to the *P* bank of the junction hunter to mark the junction as busy.

Should the regenerator fail to transmit all its stored digits, relay *BY* will hold operated and earth will be maintained from armatures *by6* and *is4* on the common conductor *11* extending to release alarm equipment which functions after a delay to provide a signal of the faulty condition.

Should the called subscriber replace his receiver after conversation and the calling subscriber omit to do so within a predetermined time, a "called subscriber held" alarm will be given from earth, armatures *db5* and *dd2*, supervisory lamp *LP* to battery via delayed alarm equipment connected to common lead *14*.

Referring now to Figs. 4, 5 and 5a, there is

shown a repeater incorporating a mechanical regenerator with arrangements for delaying regeneration of the stored pulses until the reception of a signal from the distant exchange indicating that a finder thereat has found the calling junction. The repeater is illustrated as being incorporated in an automatic telephone system which comprises a first exchange, a second exchange and one or more junction lines, such, for example, as the line 100, interconnecting the exchanges. A plurality of subscribers' lines, such, for example, as the lines 101, 102 and 103 associated respectively with the subscribers' substations A, B and C, extend to the first exchange, these lines being multiplied in the bank contacts of one or more finder switches as indicated at 104 and one or more connector switches as indicated at 105. Associated with each finder switch in a conventional manner is a selector switch which has access by way of its bank contacts to a plurality of connector switches. Thus, the finder switch 104 has associated therewith a selector switch 106 which has access to the connector switch 105 to which the line 103 extends. All of the above-noted elements embodied in the first exchange may be of any desired construction and arrangement. It is well known that the desired line selection in this type of exchange is brought about through the transmission of impulses over a calling subscriber's line from the impinging device conventionally provided at the calling substation. One such impinging device is indicated at A' for the substation A. It is also well known that the numerical selector and connector switches, such, for example, as the switches 106 and 105, are automatically operating switches and are so constructed and arranged as successively to respond to impulses transmitted thereto to perform the desired line selecting functions. Since the mode of operation of these switching elements is well known in the art, a detailed description thereof is deemed to be unnecessary. Considering now the second exchange indicated in Fig. 5a below the broken line, it will be noted that the equipment of this exchange is in all respects similar to that shown for the first exchange. In brief, the equipment embodied therein comprises an automatically operating finder switch 107 at which the junction line 100 terminates having associated therewith an automatically operating, impulse responsive selector switch 108. The last-mentioned switch in turn has access to a plurality of impulse responsive connector switches, one of which is indicated at 109, to the bank contacts of which are extended the subscribers' lines which terminate at the second exchange. Thus, the line 110 associated with the substation D is illustrated as extending to the bank contacts of the connector switch 109. Each of the elements 107, 108 and 109 may be of any desired construction and arrangement, the operation of which is well known in the art. By way of rendering the operation of the repeater illustrated in Figs. 4 and 5 more clearly understandable, however, it is pointed out that, when the junction line 100 is taken for use, the finder switch 107 or another similar switch is started in operation to find this line. When the junction line is found, the switching relay 111 is caused to operate to extend the connection through to the selector switch 108, and, as thus extended, ground is applied from the lower winding of the line relay 112 back to the positive line conductor of the junction line. With the connection extended through to the selector switch, the line relay 112 is caused

to operate to condition the selector switch 108 to be responsive to the first series of impulses transmitted thereto by way of the junction line.

Before describing in detail the operation of the apparatus shown in Figs. 4 and 5, it is noted that the association of junctions with a smaller number of incoming selectors over finders has hitherto presented difficulties because only the interdigital pause is available for the finders to complete their operation. The present arrangement, however, overcomes this limitation by providing adequate time for the finding operation.

Considering now the detailed operation of the repeater circuit as shown in Figs. 4 and 5, when the repeater is taken into use, as by the selector switch 106, on a call forwarded by way of one of the plurality of lines extending to the first exchange, the loop extended over the incoming positive and negative conductors operates relay A which thereupon operates relay B. Armature b3 applies a guard earth to the P lead and armature b3 extends earth over the negative lead of the outgoing junction line circuit to operate the line relay in the distant junction line circuit which starts up a finder switch in known manner, the usual cut-off contact to earth on the positive lead being omitted from the junction line circuit.

Upon the reception of the first series of impulses relay A responds and at armature a1 repeats the impulses to the receiving magnet MR of the mechanical regenerator or impulse register in parallel with relay C. Relay C operates and at armature c1 brings up relay IP and at armature c2 energises the marking magnet MM of the mechanical regenerator to hold the operating lever out of engagement with the marking pins. The impulses received by the magnet MR rotate the disc R step-by-step and upon the first movement of this disc the off-normal springs MN1 are closed to prepare various circuits and connect earth to the pin plate P.

At the end of the first series of impulses, relay A remains operated and upon the release of relay C after its slow period the circuit for the marking magnet MM is opened and this allows the lever carried by the disc R to release and press out a corresponding digit pin into the path of the disc S. At the same time the springs mm controlled by the marking magnet close and complete a circuit for relay BY which thereupon operates and locks at armature by1 for the remainder of the setting operation to earth on the off-normal springs MN1. Relay BY at armature by4 prepares a circuit for the sending magnet MS, at armature by3 prepares a shunt round relay IP and at armatures by5 and by6 disconnects the condensers QA and QB in order to improve the characteristics of the impinging circuit.

When the distant line finder, such, for example, as the finder switch 107, has found the calling junction, the cut-off relay operates in the usual manner and switches, through the operation of the relay 111, the junction line through to the distant incoming selector switch 108. The line relay 112 in the incoming selector provides a battery connection to the negative lead and an earth connection to the positive lead as is the usual practice and as a result relay I in the repeater circuit is now operated by way of resistance YB to the earthed positive lead. Armature i1 completes an operating circuit for relay SW from the earthed P lead and at armature sw1 relay SW locks up independently of armature i1. Armatures sw2 and sw3 thereupon disconnect the local battery and earth connections extending to the positive

and negative conductors and substitute in their place a bridge consisting of the impulse springs IMP. Relays D and I will be short-circuited at this time by armature *by6* and relay I will therefore release. Armature *sw4* polarises relay D and armature *sw5* completes the circuit for short-circuiting relay IP, while armature *sw6* energises relay IS which thereupon short-circuits its upper winding so as to make itself slow to release.

When relay IP releases due to the short circuit, it opens the circuit of relay IS which releases also and when both relays have released a circuit is completed for the sender magnet MS which pushes the normal stop pin out of the path of the sending disc S. Moreover the springs *ms* open the short-circuit round relay IP so that this relay again energises and opens the circuit of the magnet MS and enables relay IS to re-operate. The sending disc S is now released and rotates until it comes up against the stop pin indicating the termination of the first series of impulses. During the rotation of the disc S a fresh series of impulses corresponding in number to those received but correct as regards ratio and speed is generated by the springs IMP controlled from the mechanical regenerator and these impulses serve to set the incoming selector at the distant end of the line. Relay IP is again short-circuited when the disc S comes up against the stop pin indicating the termination of the first series of impulses and in turn releases relay IS to produce another momentary operation of the sending magnet MS. Thereupon the disc S is released to generate the second series of impulses and further trains are sent in a similar manner. When all digits have been received and retransmitted, the sending disc S will catch up with the receiving disc R whereupon the off-normal springs MN1 open and relays BY, IP and IS are finally released.

When the called subscriber replies, battery is reversed over the junction to cause the operation of the shunt field relay D which at armature *d1* operates relay RB. Relay RB thereupon locks up at armature *rb1* and at armatures *rb2* and *rb3* repeats the battery reversal over the calling side of the circuit, at armature *rb5* disconnects the receiving magnet MR and at armature *rb6* opens a point in the circuit of the marking magnet MM.

Upon the release of the connection at the end of the conversation, relay A releases and is followed by relay B which at armature *b5* opens the outgoing loop to release the switches 107 and 108 in the distant exchange. Relay C is operated during the slow release period of relay B and operates relay IP which at armature *ip1* maintains earth on the P conductor after the release of relay B. By this means a double guard is provided on the release trunk conductor P to ensure an adequate period for the release of the switches at the distant exchange before the repeater is again freed for further use.

In case the mechanical regenerator fails to retransmit all its stored impulses, relay BY remains operated and as a result earth is maintained on the common conductor 11 leading to release alarm equipment which functions after a predetermined period to call attention to the faulty condition.

In case the calling subscriber should release the connection prematurely by hanging up his receiver without completing dialling, the train of switches so far set up are immediately released and the repeater is guarded against further seizure until the mechanical regenerator is fully

restored to normal. In such a case of premature release relays A and B fall away as previously described and relays C and IP are operated. If the mechanical regenerator has not yet commenced to transmit impulses, this operation will be initiated by armature *b6* completing the short-circuit round relay IP. If transmission has already commenced, on the next subsequent release of relay IP earth will be removed from the P conductor for the slow period of relay IS to permit the release of the preceding switches and also to release relay SW. Subsequently the mechanical regenerator will complete its sending operation although in this case the pause between successive trains of impulses will be less than normal owing to the slugging effect on relay IS being removed at armature *sw6*. The sending operation is, of course, without effect owing to the forward loop having been opened at armature *b5*. When all the digits have been retransmitted the off-normal springs MN1 again open and relay BY is released so that earth is removed from the P conductor to enable the repeater to be seized again.

The repeater illustrated is designed for use also as an incoming repeater in which case the dotted connections between terminals 3 and 5, 4 and 6, and 9 and 10 are omitted and connections are made instead between terminals 5 and 7 and 6 and 8. As a result on the reply of the called party the operation of relay RB cuts out entirely the transmission bridges and gives a straight through connection. Guarding of the junction in this case in the event of premature release is effected by the connection of earth to the negative conductor at armature *by7* to operate a relay at the outgoing end which applies earth to the test contact in the selector bank.

Referring now to Figs. 6 and 7 and 8 and 9, it should be explained that on outgoing calls the operator plugs into the outgoing repeater and thereupon dials or keys up the required number on a key sender whereupon D. C. impulses are sent into the repeater at any speed within the limits of correction and are retransmitted as A. C. impulses over the junction. Conveniently the regenerated impulses will be transmitted at a speed of 10 per second since this has been found to be most suitable for A. C. dialling at the commercial frequency of 50 cycles. At this speed the impulses commence at the same point in the cycle with every impulse so that the operating and release conditions of the impulse accepting relay at the distant incoming relay set remain substantially constant. The A. C. to D. C. regenerator at the incoming end in the distant exchange compensates for line distortion and it is clear that with this arrangement the existing limits of commercial frequency dialling can be substantially and reliably increased.

Considering first the circuit operation of the outgoing repeater, Figs. 6 and 7, when the operator plugs into the jack, relay A operates over the loop extended over the T and R conductors and at armature *a1* operates relay B. Armature *b1* then extends a guard earth over the P lead which lights the visual engaged supervisory lamps VES round the switchboard and armature *b3* operates relays BA and CC. Armature *ba1* connects resistance YA across the T and R conductors, this resistance serving to hold relay A independently of the loop from the operator's cord circuit. Armature *cc1* completes a circuit for the slow-to-operate relay CR and armatures *cc5* and *cc6* connect the A. C. supply by way of armatures

cr5 to the outgoing negative and positive junction leads. During the operating time of relay CR a seizing pulse of A. C. is therefore extended over the junction to prepare the switches at the distant exchange for the reception of the setting digits. When relay CR operates it locks at armature cr1 and at the same time disconnects relay CC, at armature cr2 disconnects relay BA and at armature cr5 cuts off the seizing pulse. Relay BA upon releasing opens the holding circuit for relay A by way of resistance YA thereby placing this relay again under the control of the operator. This temporary locking arrangement for relay A while relay BA is operated serves to prevent false operation of the equipment in case the operator inserts the plug and rapidly withdraws it. Dial tone is now returned from the distant exchange over the junction and is extended to the operator by way of condensers QA and QB to inform her that she may now dial or key up the number.

Upon the transmission of the series of impulses corresponding to the first digit, relay A responds and at armature a1 repeats the impulses to the receiving magnet MR of the regenerator in parallel with relay C, relays B and C holding operated during the impulse train due to their slugs. It should be mentioned that just prior to and during the impulse train for instance when the dial moves off-normal earth is extended over the sleeve circuit of the jack to operate relay S and at armature s1 the regenerator marking magnet MM is energized to hold the operating lever out of engagement with the marking pins as previously described, while armature s4 disconnects relay AC from the line conductors. As soon as the regenerator receiving disc R commences to move, the off-normal springs MN1 operate and connect up earth to operate relay IP which thereupon at armature ip2 operates relay IS.

At the end of the first digit, relay S falls away and releases the magnet MM which effects registration by pushing a pin through the plate P. When the springs mm close, relay CC is again operated and locks up over armature cc2. Armature cc3 now extends an earth in the manner previously described to short-circuit relay IP and this relay after a short period releases and opens the circuit of relay IS which in turn releases after a further short interval. A circuit is now completed from springs MN1, armatures ip2, cc4 and is1 to energise the sending magnet MS which pushes the appropriate stop pin out of the path of the sending disc S. The sending magnet interrupter springs ms now open and remove the short circuit from relay IP which re-operates and in turn re-operates relay IS and at the same time releases the sending magnet MS which releases the sending disc S and causes a series of A. C. pulses correct as regards ratio and speed to be transmitted over the junction by way of springs IMP and armatures cc5 and cc6.

Further digits may have been received on the regenerator in the meanwhile and it will be appreciated that reception and transmission may take place simultaneously and that the release time of relays IP and IS in tandem provides the necessary pause between successive series of transmitted impulses.

When all digits have been sent the off-normal springs MN1 open and release relays CC, IP and IS and the regenerator comes to rest.

When the called subscriber replies, battery is reversed over the train of switches at the distant exchange and this is repeated in the form of an

A. C. impulse by the incoming repeater thereat as will presently be described. This pulse operates relay AC, the rectifiers MRA and MRB being provided to enable a standard telephone relay to operate satisfactorily on A. C. A circuit is now completed from earth, armatures b3, ac1, cb3 and cd3 to operate relay CA which locks at armature ca1 and operates relay BA at armature ca2. At the end of the pulse, relay AC releases and a circuit is completed from earth, armatures b3, ac1, ca3 and cd1 to operate relay CB which thereupon locks at armature cb1. Armatures cb4 and cb5 reverse the battery to the calling side of the circuit for supervision purposes while armature cb2 disconnects relay BA.

At the end of the conversation if the called subscriber clears first, the distant incoming repeater delivers a further pulse of A. C. over the junction which re-operates relay AC, a circuit being then completed from earth over armatures b3, ac1 and cb3 to operate relay CD. Armature cd1 thereupon locks relays CD and CB to earth via armatures cb3, ac1 and b3, armature cd2 prepares a new circuit for relay BA and armature cd3 releases relay CA. When relay CA falls away, relay BA operates from earth over armatures b3, cb2, cd2 and ca2 and thereupon again bridges resistance YA across the speaking leads. At the end of the A. C. pulse, relay AC releases and releases relays CB and CD which thereupon restore to normal the battery connections to the calling side of the circuit and release relay BA.

Should the calling subscriber clear first, relay A releases and releases relay B. During the slow release of the latter, relay C is operated and at armature c1 operates relay CC over its left-hand winding. Relay CC serves as before to extend a pulse of A. C. over the junction to release the switches at the distant office. The de-energisation of relay B releases relay CR which during its slow release time at armature cr4 maintains earth on the P conductor to guard the circuit during the extension of the releasing pulse.

If the regenerator fails to transmit all its stored digits, relay CC will be maintained operated and earth will be applied continuously from armatures cc1 and is2 to the common conductor 11 which extends to delayed alarm equipment.

Should the operator withdraw her plug prematurely during the setting up of the call, it is necessary to guard the outgoing relay set until the regenerator has completely restored to normal. On withdrawal of the plug relay A will release but relay B will be maintained operated from armature ip1 during the sending out of any digits stored. When the regenerator reaches normal, relays IP and CC restore and relays B and CR then release whereupon the VES lamps will be extinguished thus indicating that the circuit is ready to deal with a further call.

Considering now the incoming repeater, Figs. 8 and 9, which is connected to the distant end of the junction line and which may have associated therewith a selector switch as shown in Fig. 5a, when the seizing pulse of A. C. is received, relay AC operates and at armature ac1 operates relay A. This latter relay at armature a1 operates relay B, and armature b4 thereupon applies a guard earth to the P conductor. At the termination of the pulse, relay AC falls away and releases relay A but relay B remains locked to earth via armature b1. A loop is now extended to the associated local automatic switch by way of the windings of relays D and I, the regenerator impulse springs IMP and armatures a2, b2 and b3 and

when this switch is prepared for operation dial tone is extended back over the junction to the operator by way of the outgoing repeater (Figs. 6 and 7) at the distant end. Relays D and I are shunted by rectifiers MRC and MRD respectively and due to the direction of current flow provided from the line relay of the selector, rectifier MRD will be in a conductive direction and will therefore short-circuit relay D while rectifier MRC will be in a non-conductive direction thus allowing relay I to operate. Relay I thereupon at armature *i2* prepares a circuit for the receiving magnet MR and armature *i4* completes a circuit for relay DX which locks up.

On the reception of the first series of A. C. pulses from the distant exchange, relay AC responds and each time it energizes, relay A and the receiving magnet MR of the regenerator are energized in parallel. On the first operation of relay AC the short-circuit is removed from relay C and it immediately operates in series with relay DX, thereupon at armatures *c2* and *c3* preventing the received A. C. impulses from affecting the local automatic switches. Each time relay AC releases during the impulse train relay C is short-circuited but it holds up during this period. Armature *c1* provides an independent holding circuit for relay C by way of resistance YA and armature *c6* operates the regenerator marking magnet MM for the purpose previously described. The regenerator off-normal springs MN1 operate as soon as the receiving disc R commences movement and operate relay IP which thereupon operates relay IS.

At the end of the first digit, relay AC restores thus short-circuiting relay C for a time interval of sufficient length to effect its release whereupon at armature *c6* the marking magnet MM is de-energized to complete at springs *mm* a circuit for relay BY. Armature *by1* short circuits relay IP and causes it to release in the manner previously described and at armature *ip1* relay IS is in turn released. A circuit is then completed over armatures *ip1*, *by4* and *is1* to energize the sending magnet MS to start the sending operation. The sending magnet springs *ms* then open and remove the short-circuit from relay IP which re-operates and de-energizes the magnet and the sending disc S is then freed and commences to rotate to the next stop pin. D. C. impulses are now transmitted to the automatic switches by way of a loop comprising armature *by1*, regenerator impulse springs IMP, armatures *by6*, *b2* and *b3* and the negative and positive conductors. When all digits have been received and retransmitted, the regenerator off-normal springs MN1 open and release relay BY which thereupon releases relays IP and IS.

When the called subscriber answers, battery is reversed thus releasing relay I and operating relay D. Armature *d1* completes a circuit from earth, armatures *ac1*, *b5*, *er1*, *dr1* and *d1* to operate relay E over its upper winding and at armature *e1* relay E is locked independently of relay D. Armature *e4* completes a circuit for the slow-operate relay DR which operates after a short period and at armature *dr1* locks up and disconnects relay E. During the period of operation of relay E a pulse of A. C. is sent back for metering or supervisory purposes to the outgoing repeater at the distant end of the junction by way of armatures *e2* and *e3*. Armature *dr3* releases relay DX.

At the conclusion of the conversation when the calling subscriber hangs up, a long A. C. impulse

is transmitted over the junction from the outgoing repeater at the distant exchange and operates relay AC which at armature *ac1* operates relay A. Due to the removal of the short-circuit, relay C now operates and at armatures *a1* and *c4* relay B is short-circuited. Since the release pulse is of longer duration than the slow release period of relay B the latter releases and initiates the release of the train of local automatic switches. At the end of the pulse relay AC releases and brings down relay A which short-circuits and releases relay C.

Should the called subscriber clear first, relay D releases and a circuit is completed to operate relays E and ER in series from earth, armatures *c5*, *d2* and *dr2*, winding of relay ER, armature *dr2*, lower winding of relay E to battery. Armature *er1* thereupon disconnects relay DR which releases after a slow period and in turn brings down relays ER and E. During the period relay E is energized a pulse of A. C. is extended back over the junction to the outgoing repeater for supervisory purposes.

In case the regenerator fails to transmit all its stored impulses, relay BY holds operated with relay IS normal and as a result earth is extended by way of armatures *by3* and *is2* on to common lead 11 to which is connected equipment arranged to give a delayed alarm.

The invention may also be conveniently employed in connection with register translators of the known type which translate the three exchange name digits and transmit four numerical digits unaltered. In such equipment economy may be achieved by substituting a mechanical impulse repeater for the four rotary switches usually provided for storing the numerical digits. If the units switch performs also a digit distributing function as is sometimes the case, this could be taken care of by a group of relays or by the sender switch with some slight modification of its circuits.

A further application of the invention is in connection with alternative routing for dealing with overflow trunking problems. In such cases a switch may have access to a limited number of direct junctions and if all of these are busy, to overflow lines for extending the connection over a more circuitous route which will ordinarily require at least one extra series of impulses. It is still necessary however to send over the overflow lines the complete series of impulses dialled by a subscriber. The subscriber will not pause in his dialling while the alternative routing operation is going on as he is unaware of it and it is therefore necessary to repeat the first series of impulses. With a regenerator associated with the switch having alternative routing facilities, the regenerator can store all the digits required to set up the connection including if necessary the one which operates its associated switch. If the call can be completed over the direct route, the digits stored in the regenerator can be disposed of subsequently without effect. If on the other hand an overflow line is taken into use, the mechanical regenerator can be used to set up the remainder of the connection after the desired exchange has been reached.

Yet another application is in connection with private automatic branch exchanges in which an operator controls the taking into use of outgoing lines. In these circumstances the duties of a busy operator could be considerably lightened by arranging for subscribers requiring out-service to dial the full number of the desired subscriber

on to a regenerator which would signal the operator that an external connection was desired. A group of regenerators would be provided to handle simultaneous calls and the operator could associate them with outgoing lines as and when they became available. The operator in this instance would perform the function of a traffic distributor and would be relieved of the necessity of noting the numbers and setting up outgoing calls.

10 A still further possible application is to an automatic telephone system in which group selection is made by simple single motion switches responding only to setting digits and performing no hunting operation but arranged to start up
15 large capacity finder switches in the selected group whereby full availability of bank contacts is obtained. As is well-known, in medium-sized exchanges employing forward decimal selection, various levels of the first selectors are never used.
20 Further, owing to the limited availability of each level full availability to each rank of selectors cannot be given. It is therefore proposed according to the invention that subscribers' line finders be connected to link circuits including a regenerator
25 for which would store certain or all of the digits of the desired number. The regenerator would be arranged to control ten-point uniselectors to mark and start up a large capacity finder switch in say the correct thousands group and when this
30 had found the calling circuit, the regenerator could control a further unisector to mark and start up a large capacity finder in the correct hundreds group. The final selectors would be connected back to back with the hundreds group
35 line finders and would be directly set by the regenerator into engagement with the desired line. With this arrangement it is necessary for the regenerator to be revertively controlled and this could be achieved by utilising the momentary
40 break in the line at each switching stage as an initiating signal for the transmission of the next series of impulses. The extent of the advantages of this arrangement would depend on the precise circumstances of each case but it
45 possesses the undoubted advantage of full availability groups throughout and the entire elimination of selector outlet grading with its engineering and installation problems.

We claim:

50 1. In an automatic telephone system, a junction line, said line having an outgoing end and an incoming end, an automatic switch associated with the incoming end of said line and adapted to be conditioned to respond to impulses transmitted thereto by way of said line, impulse registering means associated with the outgoing end
55 of said line and operative when said line is taken for use to store a plurality of series of impulses transmitted thereto and to repeat said impulses over said line, and means for causing said impulse
60 registering means to repeat said impulses over said line responsive to the conditioning of said switch to respond to said repeated impulses.

2. In an automatic telephone system, a first exchange, a second exchange, a junction line interconnecting said exchanges, a plurality of lines extending to said first exchange, automatic switching equipment in said first exchange and responsive to the forwarding of a call by way of one of said plurality of lines for seizing said junction
70 line, an automatic switch in said second exchange adapted to be conditioned to respond to impulses transmitted thereto, means responsive to the seizure of said junction line for associating said
75 automatic switch with said junction line and for

conditioning said switch to respond to impulses transmitted thereto over said junction line, impulse registering means for storing a plurality of series of impulses transmitted thereto over said one of said plurality of lines and for repeating
5 said impulses over said junction line, and means for causing said impulse registering means to repeat said impulses over said junction line responsive to the conditioning of said switch to respond to said repeated impulses.

3. In an automatic telephone system, a first exchange, a second exchange, a junction line interconnecting said exchanges, a plurality of lines extending to said first exchange, automatic switching equipment in said first exchange and responsive to the forwarding of a call by way of one of said plurality of lines for seizing said junction line, an automatic switch in said second exchange adapted to be conditioned to respond to impulses transmitted thereto, means responsive
10 to the seizure of said junction line for associating said automatic switch with said junction line and for conditioning said switch to respond to impulses transmitted thereto over said junction line, impulse registering means for storing a plurality of series of impulses transmitted thereto
15 over said one of said plurality of lines and for repeating said impulses over said junction line, and means included in said automatic switch and operative only when said switch is conditioned to respond to impulses transmitted thereto for initiating the operation of said impulse
20 registering means to repeat said impulses over said junction line.

4. In an automatic telephone system, a first exchange, a second exchange, a junction line interconnecting said exchanges, a plurality of lines extending to said first exchange, automatic switching equipment in said first exchange and responsive to the forwarding of a call by way of one of said plurality of lines for seizing said junction line, an automatic switch in said second exchange adapted to be conditioned to respond to impulses transmitted thereto, means responsive to the seizure of said junction line for associating said automatic switch with said junction line and for conditioning said switch to respond to impulses transmitted thereto over said junction line, impulse registering means for storing a plurality of series of impulses transmitted thereto
50 over said one of said plurality of lines and for repeating said impulses over said junction line, a relay associated with said automatic switch and operative a short time interval after said junction line is taken for use to condition said switch to respond to impulses transmitted thereto, and means responsive to the operation of said relay for initiating the operation of said impulse registering means to repeat said stored impulses over
55 said junction line.

5. In an automatic telephone system, a first exchange, a second exchange, a junction line interconnecting said exchanges, said junction line comprising a plurality of conductors, a plurality of lines extending to said first exchange, automatic switching equipment in said first exchange and responsive to the forwarding of a call by way of one of said plurality of lines for seizing said junction line, an automatic switch in said second exchange adapted to be conditioned to respond to impulses transmitted thereto, a relay in said first exchange, an operating circuit for said relay including one of said conductors, means responsive to the seizure of said junction line for associating said automatic switch with said
75

junction line, for conditioning said switch to respond to impulses transmitted thereto over said junction line and for completing said circuit, impulse registering means for storing a plurality of series of impulses transmitted thereto over said one of said plurality of lines and for repeating said impulses over said junction line, and means responsive to the operation of said relay for initiating the operation of said impulse registering means to repeat said stored impulses over said junction line.

6. In an automatic telephone system, a first exchange, a second exchange, a junction line interconnecting said exchanges, said junction line comprising a plurality of conductors, a plurality of lines extending to said first exchange, automatic switching equipment in said first exchange and responsive to the forwarding of a call by way of one of said plurality of lines for seizing said junction line, an automatic switch in said second exchange adapted to be conditioned to respond to impulses transmitted thereto, means responsive to the seizure of said junction line for associating said automatic switch with said junction line, a first relay operative in response to the association of said automatic switch with said junction line for conditioning said switch to respond to impulses transmitted thereto over said junction line, a second relay included in said first exchange, an operating circuit for said second relay including one of said conductors, means responsive to the operation of said first relay for completing said circuit, impulse registering means for storing a plurality of series of impulses transmitted thereto over said one of said plurality of lines and for repeating said impulses over said junction line, and means responsive to the operation of said second relay for initiating the operation of said impulse registering means to repeat said stored impulses over said junction line.

7. In an automatic telephone system, a junction line, a repeater at which said junction line terminates, an automatic switch adapted operatively to be associated with said junction line when said line is taken for use and to be conditioned to respond to impulses transmitted thereto over said line, impulse registering means included in said repeater for storing a plurality of series of impulses transmitted thereto when said line is taken for use and for repeating said impulses over said line, and means for preventing said impulse registering means from repeating said impulses over said line until said switch is conditioned to respond to said impulses.

8. In an automatic telephone system, a junction line, a repeater at which said junction line terminates, an automatic switch adapted operatively to be associated with said junction line when said line is taken for use and to be conditioned to respond to impulses transmitted thereto over said line, impulse registering means included in said repeater for storing a plurality of series of impulses transmitted thereto when said line is taken for use and for repeating said impulses over said line, and means included in said automatic switch and operative when said switch is conditioned to respond to said impulses for initiating the operation of said impulse registering means to repeat said stored impulses over said junction line.

9. In a telephone system, a plurality of subscribers' lines, a junction line, an outgoing repeater at which the outgoing end of said line terminates, an incoming repeater at which the incoming end of said line terminates, an auto-

matic switch, means responsive to the forwarding of a call by way of one of said lines for taking said outgoing repeater for use, means included in said outgoing repeater and operative during the conditioning thereof for use for transmitting alternating current over said junction line for a relatively short time interval, means included in said incoming repeater and energized by said alternating current for conditioning said incoming repeater and said automatic switch for use, means including said outgoing and incoming repeaters, said junction line and said automatic switch for establishing a connection between the calling one of said lines and a selected called one of said lines, means included in said outgoing repeater and responsive to the interruption of said connection at the calling end of said connection for applying alternating current to said junction line for a time interval substantially greater than said first-mentioned time interval, and means responsive only to the application of alternating current to said junction line for said greater time interval for initiating the release of said automatic switch.

10. In a telephone system, a plurality of subscribers' lines, automatically operating means including an impulse registering device and at least one impulse responsive automatic switch for establishing a connection between two of said lines, said device being operative to store a plurality of series of impulses and thereafter to transmit said stored impulses at a predetermined speed to said one switch, and means for controlling said device to reduce the time of transmission of said impulses in the event said connection is released before it is fully established.

11. In a telephone system, a plurality of subscribers' lines, a repeater including an impulse registering device, a junction line terminating at said repeater, an automatic switch associated with said junction line, said device being operative to store a plurality of series of impulses and thereafter to transmit said stored impulses at a predetermined speed to said switch, means including said repeater, said junction line and said switch for establishing a connection between two of said lines, and means for controlling said device to reduce the time of transmission of said impulses in the event said connection is released before it is fully established.

12. In a telephone system, a first exchange, a plurality of lines extending to said exchange, a second exchange, a plurality of lines extending to said second exchange, a junction line interconnecting said exchanges, an impulse registering device associated with the end of said junction line which terminates at said first exchange, an automatic switch associated with the end of said junction line which terminates at said second exchange, said device being operative to store a plurality of series of impulses transmitted thereto during the forwarding of a call by way of one of the plurality of lines extending to said first exchange and thereafter operative to transmit said impulses over said junction line to said switch, and means for preventing said impulses from being transmitted to said switch in the event said call is to be forwarded to a second of said plurality of lines extending to said first exchange.

13. In a telephone system, a first exchange, a plurality of lines extending to said exchange, a second exchange, a plurality of lines extending to said second exchange, a junction line interconnecting said exchanges, an impulse register-

ing device associated with the end of said junction line which terminates at said first exchange, an automatic switch associated with the end of said junction line which terminates at said second exchange, said device being operative to store a plurality of series of impulses transmitted thereto during the forwarding of a call by way of one of the plurality of lines extending to said first exchange and thereafter operative to transmit said impulses over said junction line to said switch, and means for preventing said impulses from being transmitted to said switch in the event only a portion of said plurality of series of impulses are transmitted to said device.

14. In a telephone system, a first exchange, a plurality of lines extending to said exchange, a second exchange, a plurality of lines extending to said second exchange, a junction line interconnecting said exchanges, an impulse registering device associated with the end of said junction line which terminates at said first exchange, an automatic switch associated with the end of said junction line which terminates at said second exchange, said device being operative to store a plurality of series of impulses transmitted thereto during the forwarding of a call by way of one of the plurality of lines extending to said first exchange and thereafter operative to transmit said impulses over said junction line to said switch, means for preventing said impulses from being transmitted to said switch in the event only a portion of said plurality of series of impulses are transmitted to said device, and means for causing said device to transmit, without effect, any impulses stored therein and comprising less than said plurality of series of impulses.

15. In an automatic telephone system, a first exchange, a second exchange, a plurality of junction lines interconnecting said exchanges, a plurality of subscribers' lines extending to said first exchange, automatic switching equipment in said first exchange for extending a call initiated on any one of said subscribers' lines to a selected second subscriber's line or by way of one of said junction lines to said second exchange, said equipment being responsive to impulses transmitted thereto over said one of said plurality of lines and including; means responsive to one series of impulses comprising a predetermined number of impulses for selecting one of said junction lines, means responsive to two successive series of impulses each comprising said predetermined number of impulses for selecting one of said subscribers' lines, and means responsive to a single series of impulses comprising a number of impulses different from said predetermined number for selecting one of said junction lines.

16. In a switch for at times extending connection over a trunk line, means for receiving and storing impulses transmitted to said switch to control the extension of a call, means for determining whether said call is to be extended over a trunk line, means effective if said call is to be extended over a trunk line according to said determination for seizing a trunk line and transmitting the stored impulses thereover.

17. In a switch having access to lines of different classes, means responsive to the receipt of impulses both for causing said switch to extend a connection to one of said lines and for

causing the received impulses to be stored, means effective only if said connection is extended to a line of a predetermined class for causing said stored impulses to be transmitted over said line.

18. In a telephone system, an automatic switch, lines accessible to said switch, means for seizing said switch and for transmitting trains of impulses thereto to extend a call, means associated with said switch for receiving and storing said trains of impulses, means for determining from a part of said received trains of impulses whether said call is to be extended over one of said lines, means effective if said call is to be extended over one of said lines according to said determination for seizing an idle one of said lines and for transmitting said impulses thereover.

19. In a telephone system, an automatic switch, lines accessible to said switch, means for seizing said switch and for transmitting trains of impulses thereto to extend a call, means associated with said switch for receiving said trains of impulses and at times for repeating them over one of said lines, means for determining from a part of said received trains of impulses whether said call is to be extended over one of said lines, means for preventing said impulse receiving means from repeating said received trains of impulses until said determination has been completed.

20. In a system such as claimed in claim 19 wherein said determination at times requires more trains of received impulses than at other times.

21. In a telephone system, an automatic switch, local lines and outgoing lines accessible to said switch, means for seizing said switch and for transmitting trains of impulses thereto to extend a call, means in said switch for receiving and storing said trains of impulses, means in said switch for determining from a part of said received trains of impulses whether said call is a local or an outgoing call, means responsive to the completion of said determination and effective only if said call is an outgoing call according to said determination for seizing one of said outgoing lines and for causing the stored trains of impulses to be transmitted thereover to extend said call.

22. In a telephone system, an automatic switch having access to a plurality of lines, a second automatic switch having access to a plurality of other lines and also to said first switch, means for seizing said second switch and for transmitting impulses thereto to extend a call, means associated with said second switch for receiving and storing said trains of impulses, said second switch effective at times to extend said call to one of said first plurality of lines in accordance with said received trains of impulses and at other times to extend a connection to said first switch, said first switch effective to search for and seize an idle one of said plurality of other lines responsive to said extension of said last connection, means responsive to said seizure for causing the trains of impulses stored in said impulse receiving means to be transmitted over said seized line to extend said call.

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