April 19, 1949. J. W. McCLEW ET AL 2,467,490

TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

Filed March 24, 1945 17 Sheets-Sheet 1

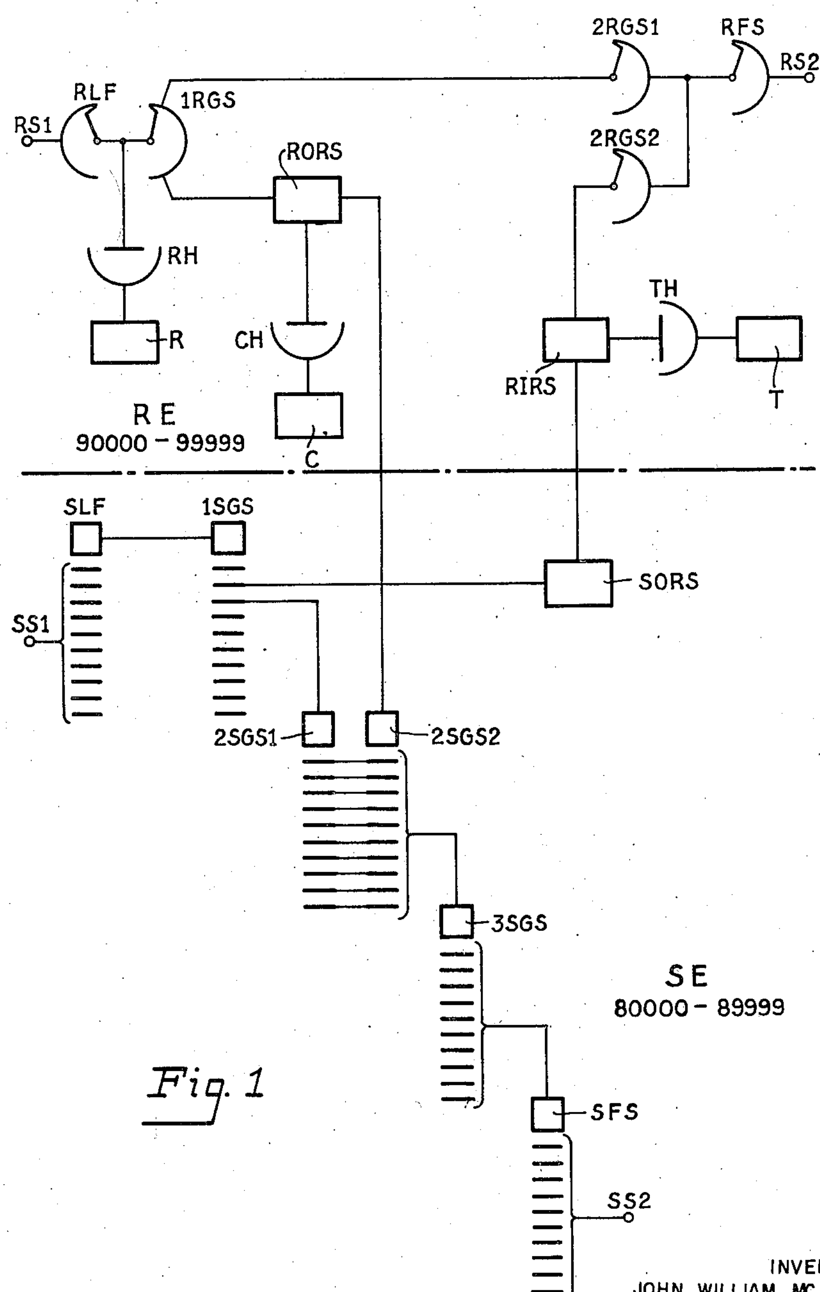

Fig. 1

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Filed March 24, 1945 17 Sheets-Sheet 2

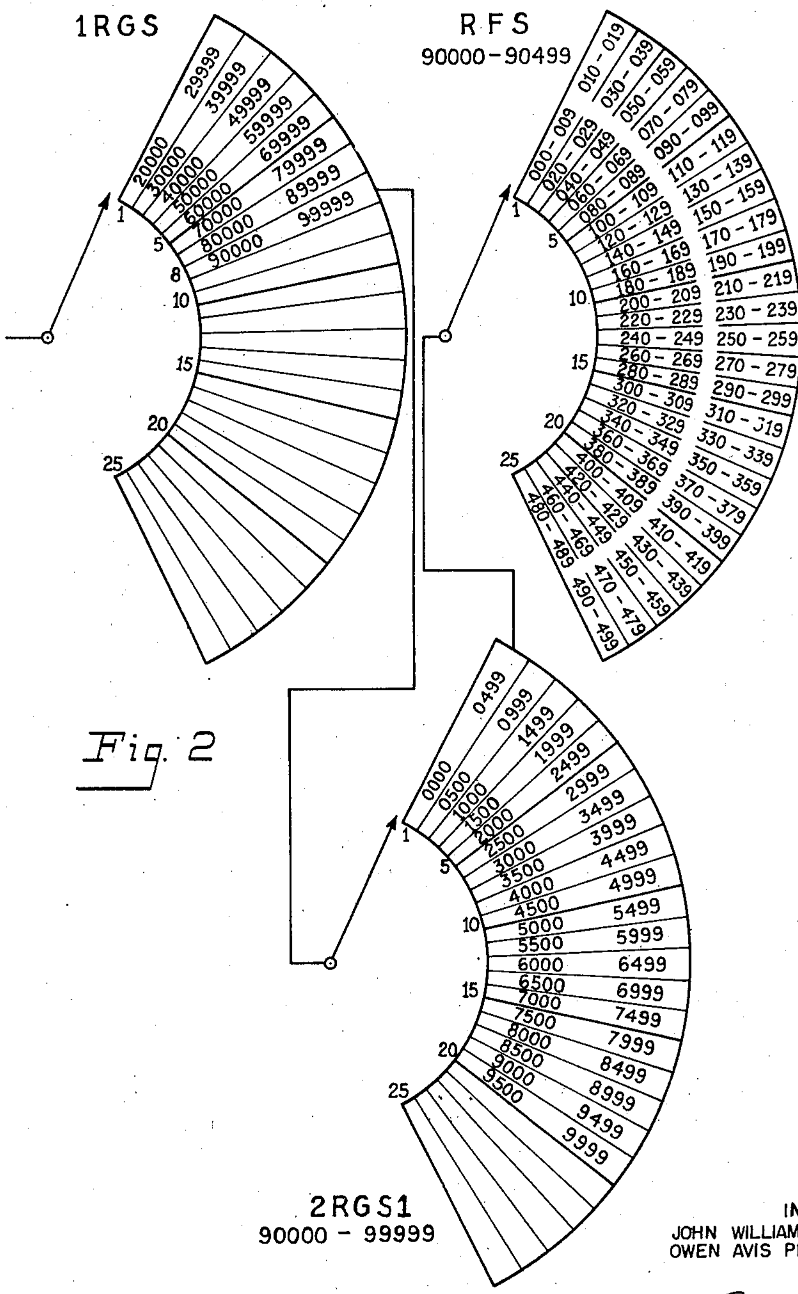

Fig. 2

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TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

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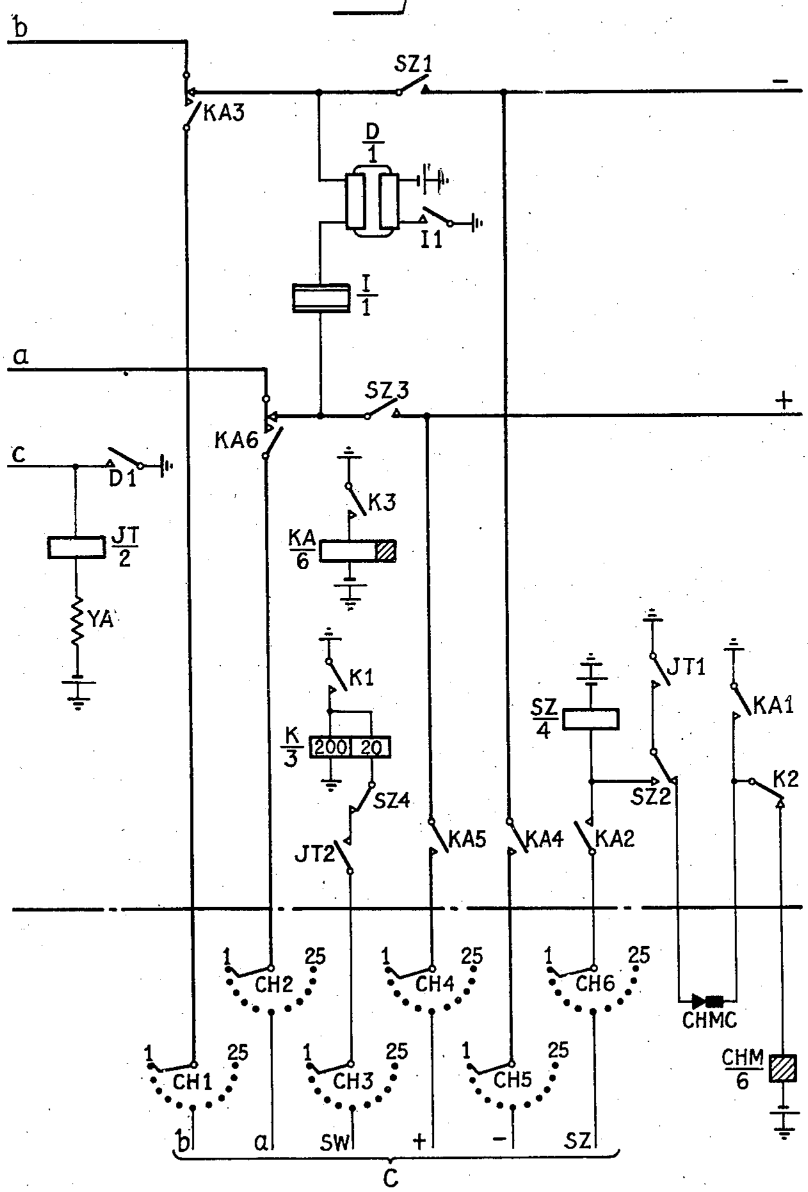
Fig. 3



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TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

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Fig. 4

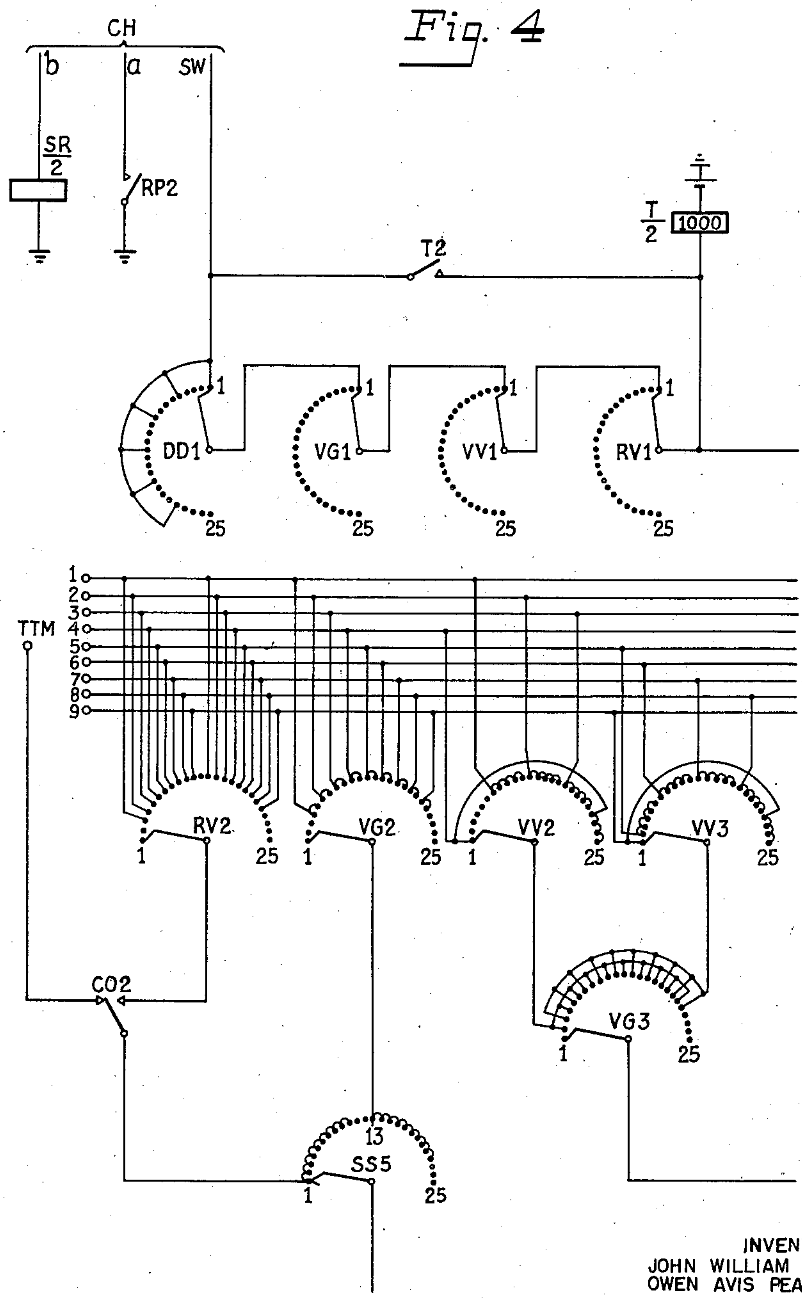

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Fig. 5

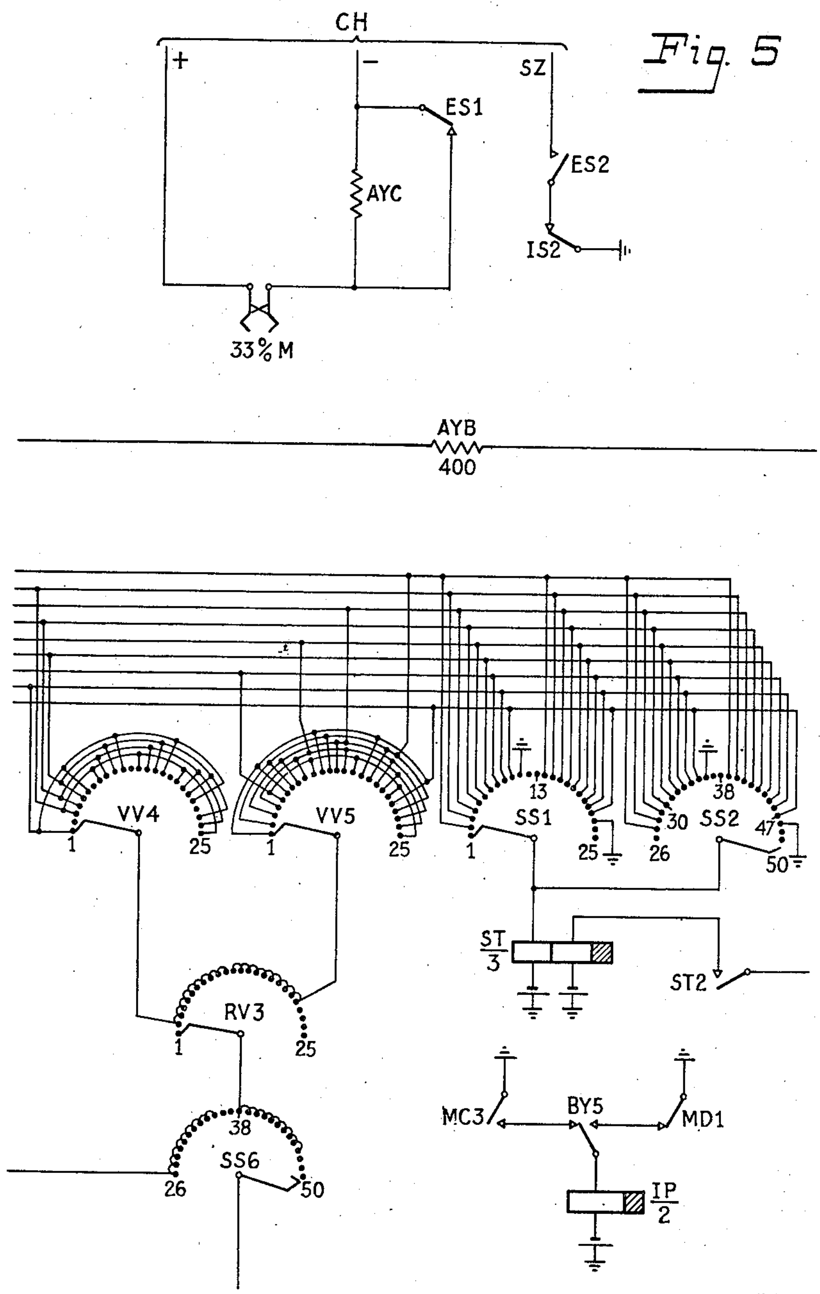

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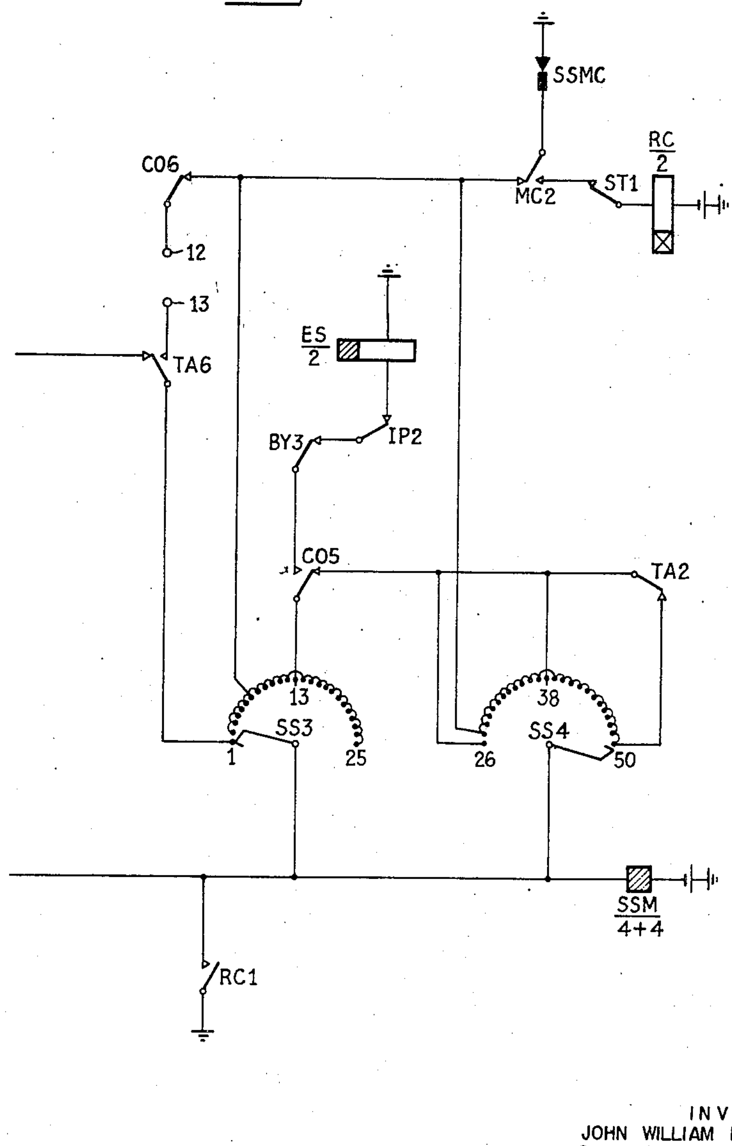
Fig. 6



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TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

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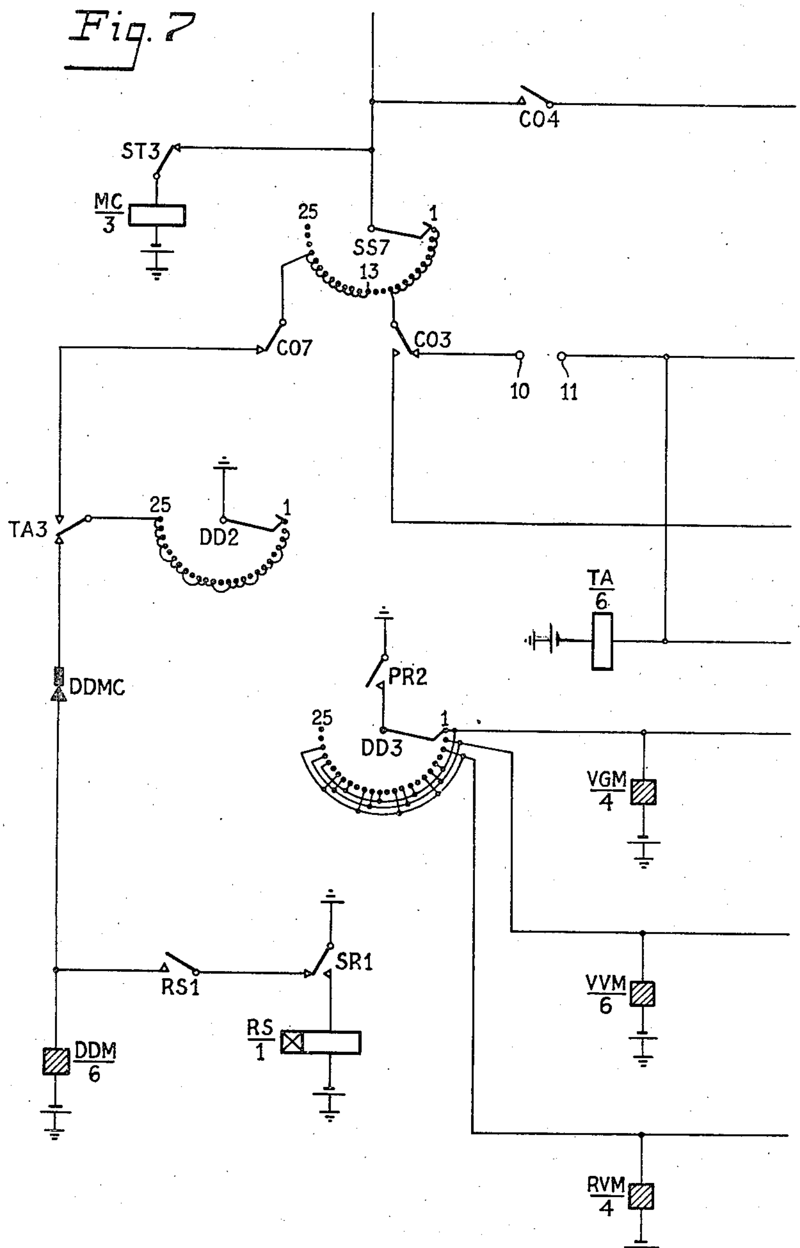
Fig. 7



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TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

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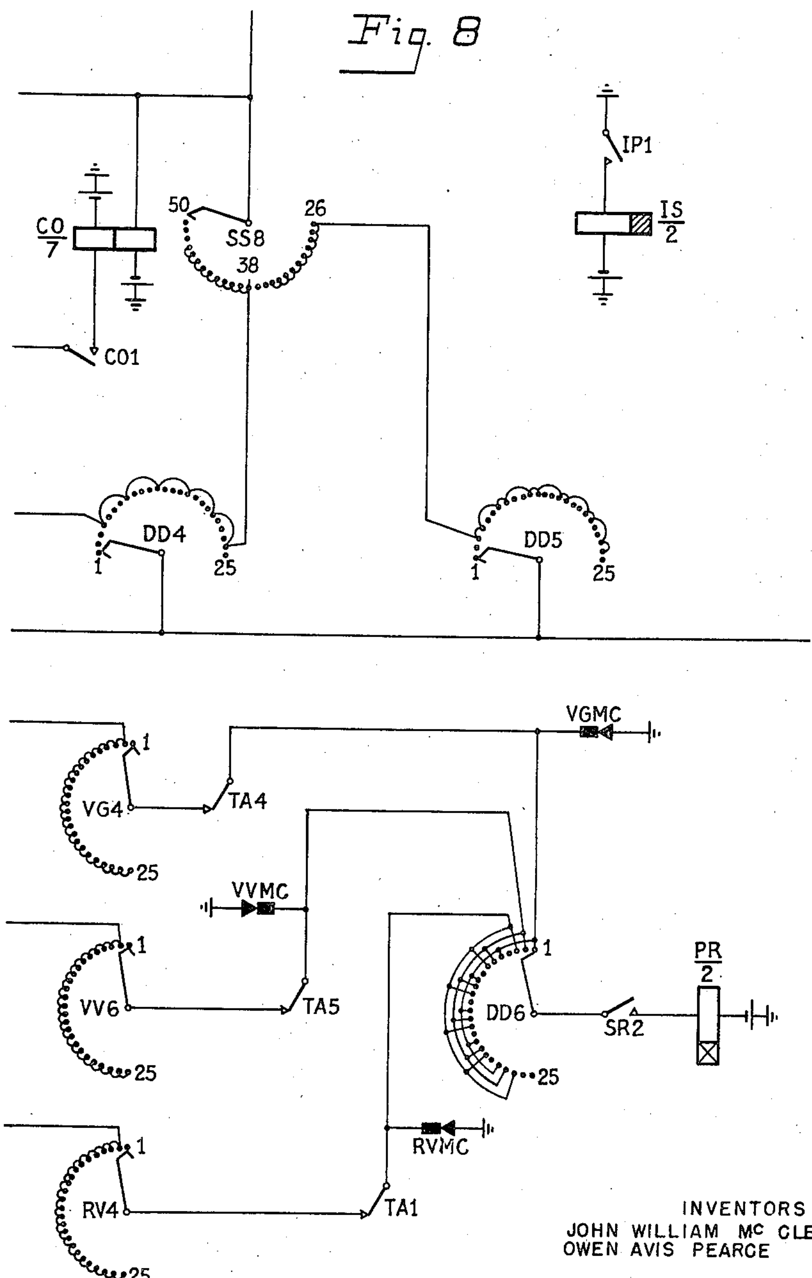
Fig. 8



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TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

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Fig. 9

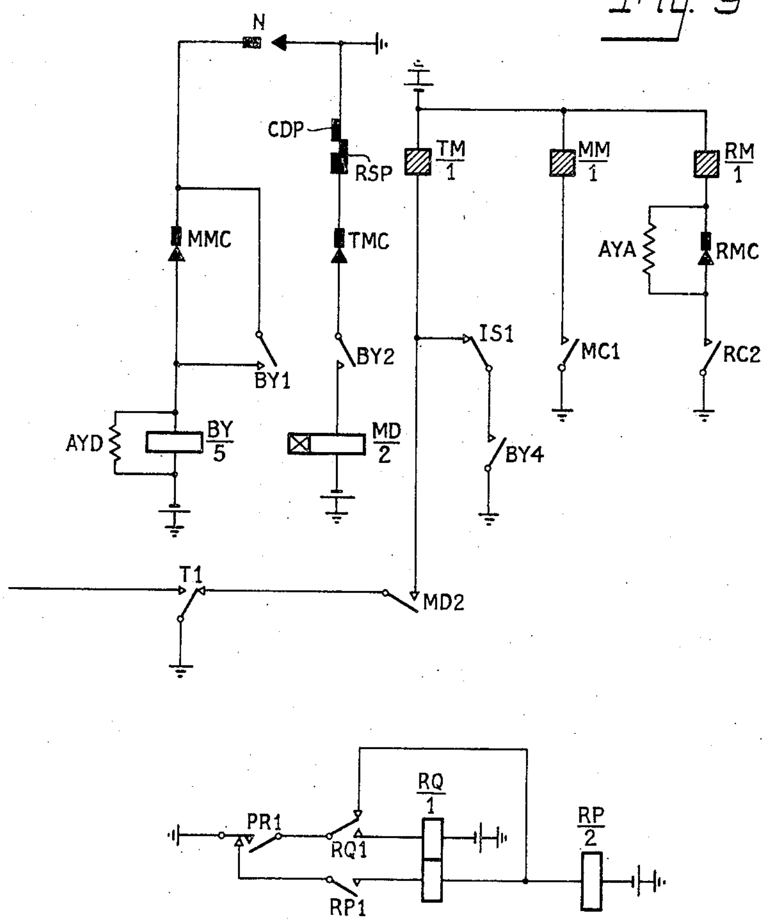

Fig. 10

4	5	6
7	8	9

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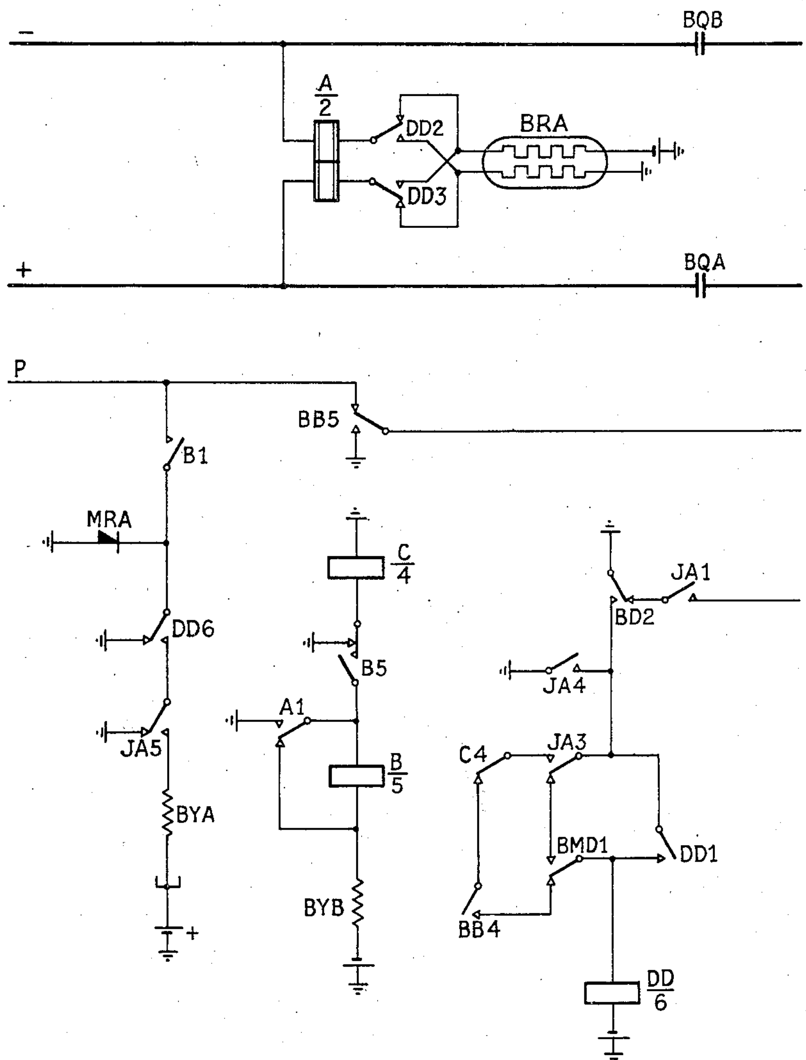
Fig. 11



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TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

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Fig. 12

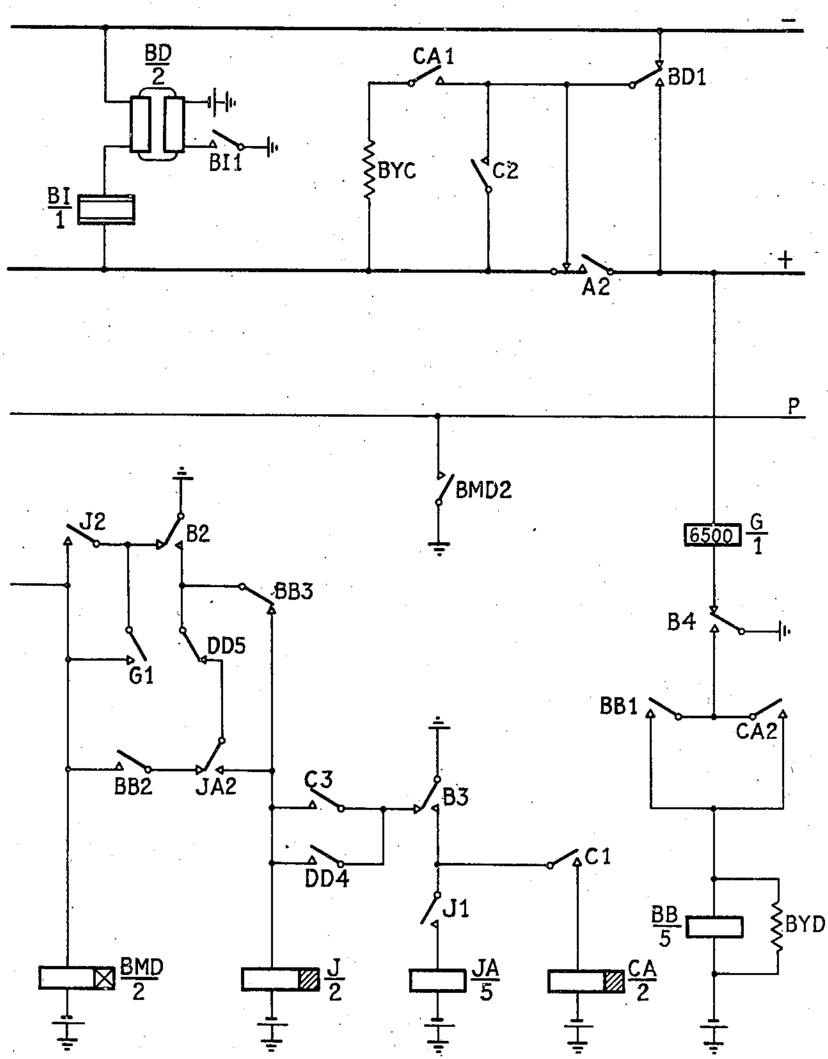

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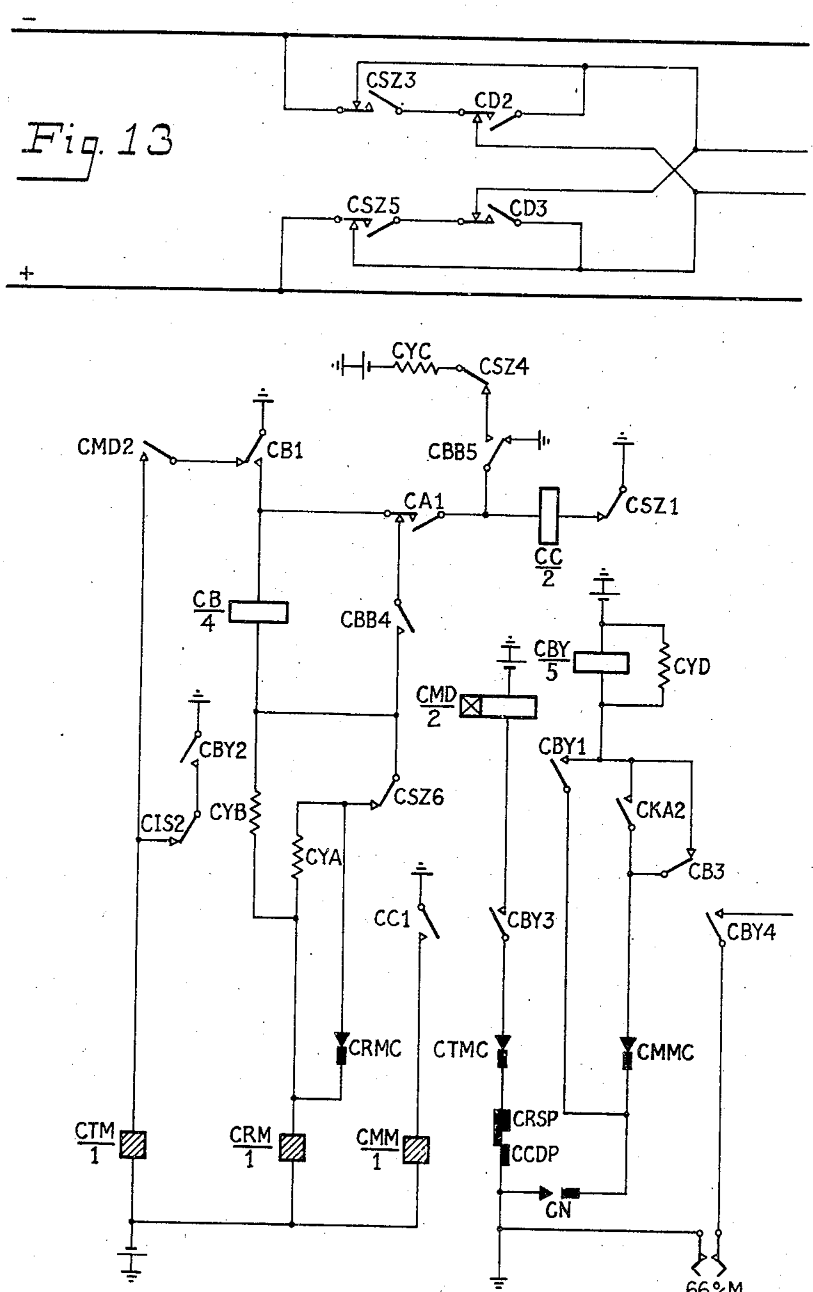
Fig. 13



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Filed March 24, 1945 17 Sheets-Sheet 13

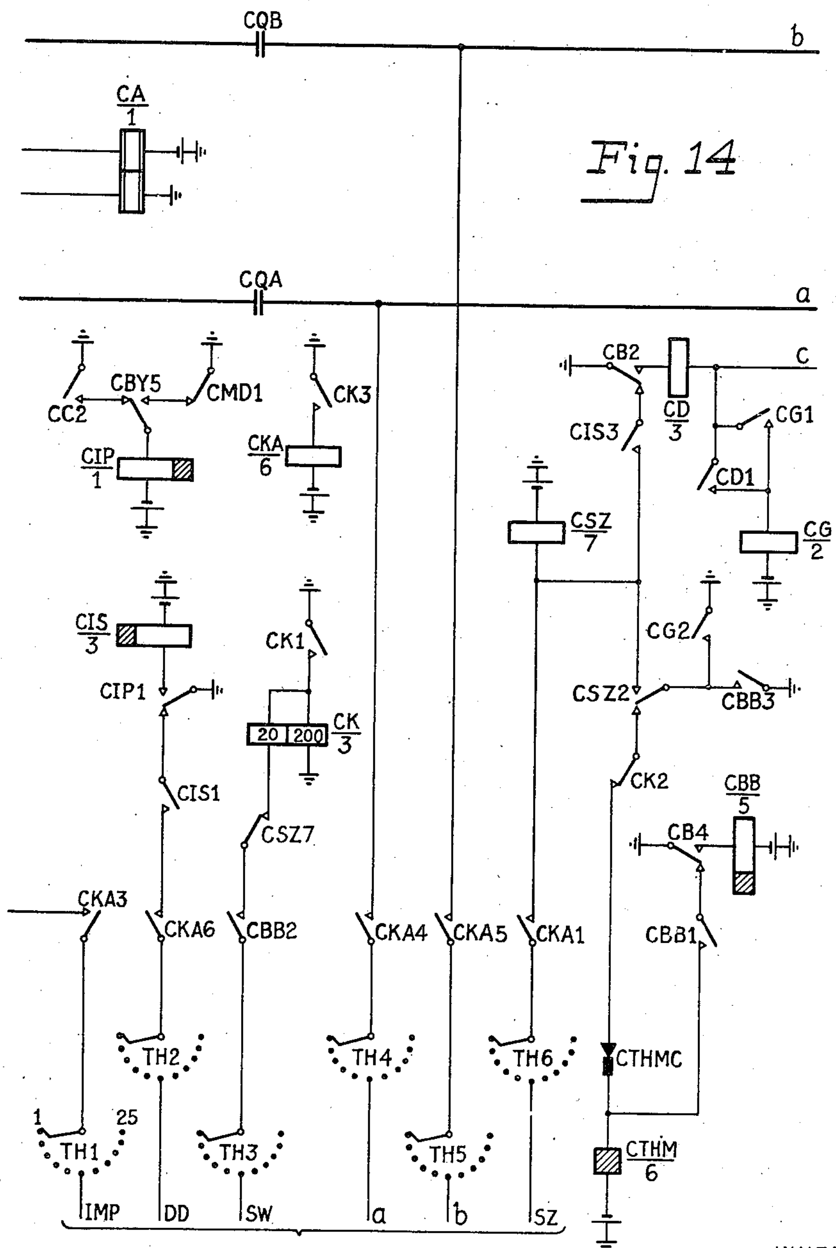

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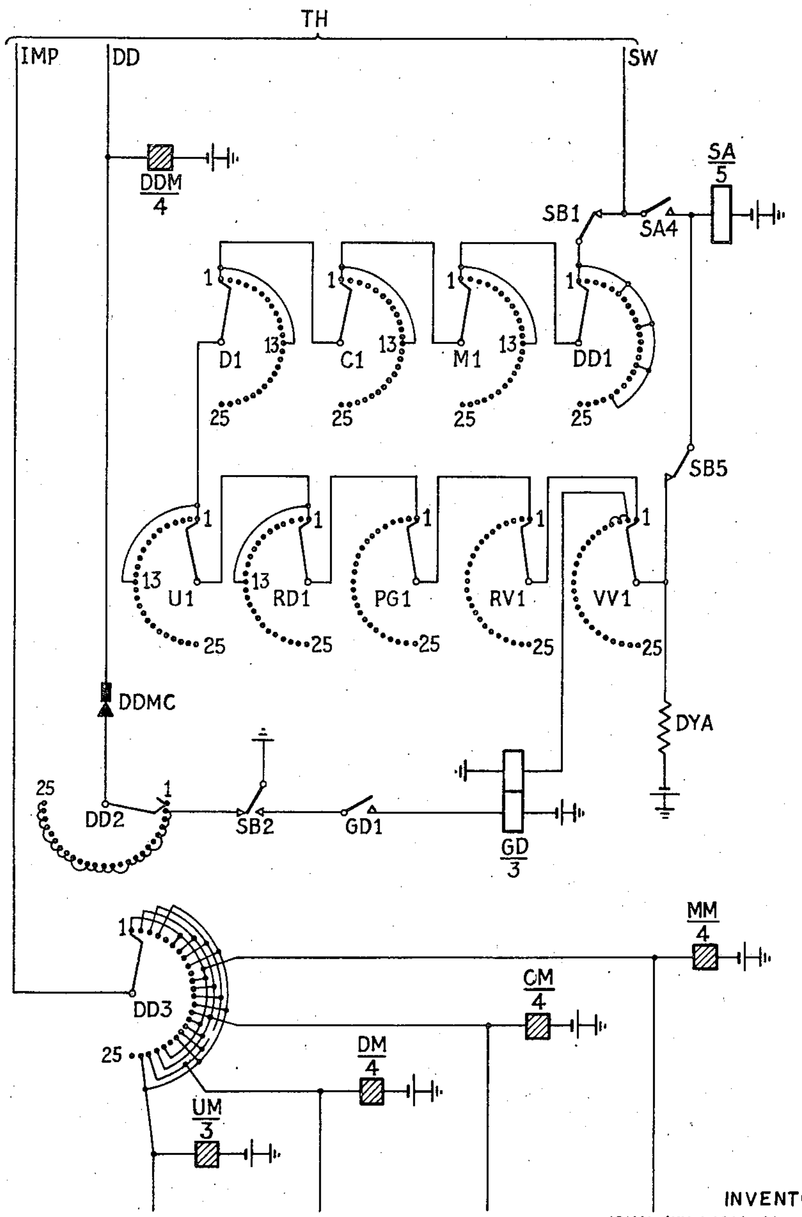
Fig. 15



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TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

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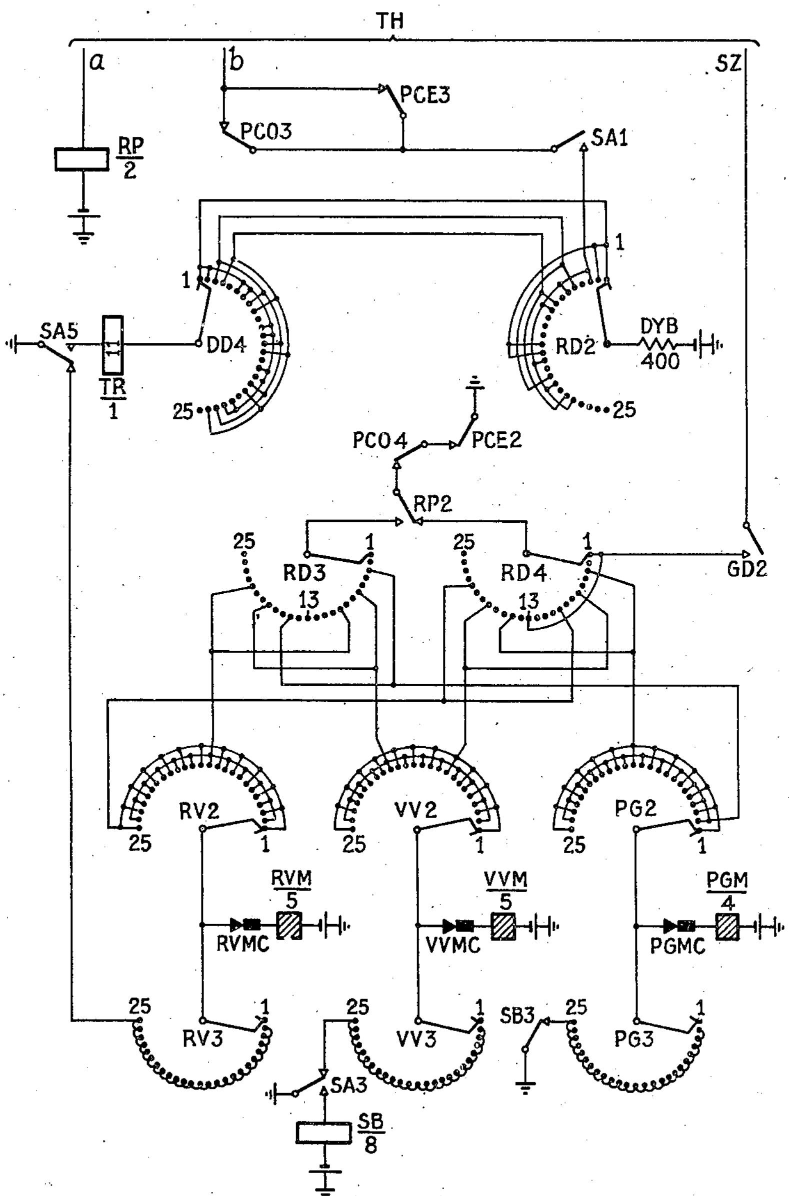
Fig. 16



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TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

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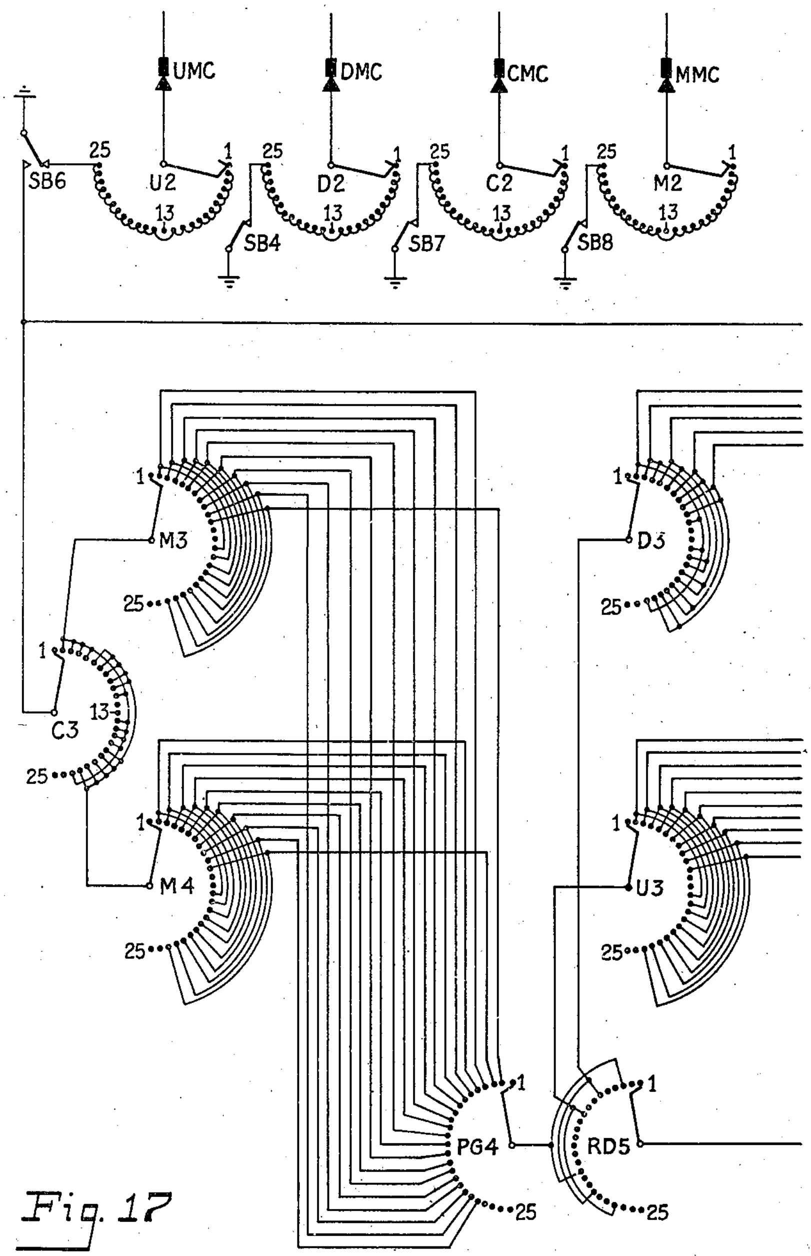

Fig. 17

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TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

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Fig. 18

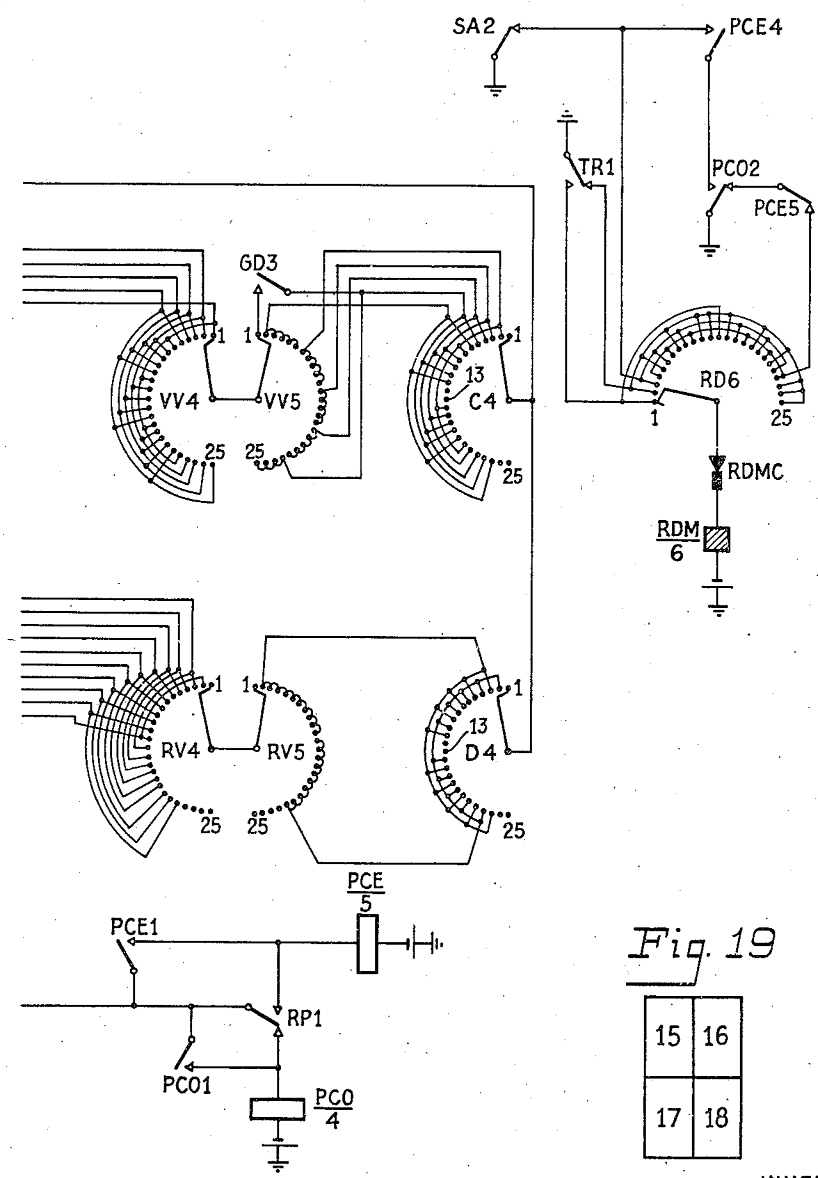

Fig. 19

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Patented Apr. 19, 1949 2,467,490

UNITED STATES PATENT OFFICE

2,467,490

TELEPHONE CONNECTION BETWEEN EXCHANGES OF THE DECIMAL STEP-BY-STEP TYPE AND THE NONDECIMAL REVERTIVE IMPULSE CONTROL TYPE

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Application March 24, 1945, Serial No. 584,510
In Great Britain April 1, 1944

12 Claims. (Cl. 179—16)

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The present invention relates to telephone systems and in particular to systems including one or more exchanges employing switches operating on a direct setting decimal basis and one or more exchanges employing switches operating on a revertive control non-decimal basis. It has for its general object to provide interworking arrangements which will function to couple the above two types of exchange without necessitating alteration to the apparatus of either kind.

According to one feature of the invention, interworking between exchanges of the two types is catered for by the provision at the non-decimal exchange of equipment adapted to co-operate with switch-controlling registers thereat to transmit impulses on a decimal basis to the decimal exchange and of further equipment adapted to respond to impulses on a decimal basis transmitted from the decimal exchange and to control the setting of the revertively controlled switches in accordance therewith.

According to another feature of the invention in a telephone system including an exchange employing switches operating on a direct setting demical basis and an exchange employing switches operating on a revertive control non-decimal basis, equipment located at the non-decimal exchange for co-operating with switch-controlling registers thereat includes an impulse storage and regenerating device for transmitting impulses on a decimal basis for operating the switches in the decimal exchange.

According to a further feature of the invention, in a telephone system including an exchange employing switches operating on a direct setting decimal basis and an exchange employing switches operating on a revertive control non-decimal basis, equipment located at the non-decimal exchange for responding to impulses on a decimal basis from the decimal exchange includes an impulse storage and regenerating device adapted to respond to impulses transmitted over a junction from the decimal exchange during the time that a non-numerical switch which is set in operation when the junction is seized is hunting for an idle set of registering equipment which is available in common to a group of incoming junctions.

The invention will be better understood from the following description of one method of carrying it into effect, reference being had to the accompanying drawings comprising Figs. 1–19.

Of these, Fig. 1 shows a trunking diagram of two interlinked exchanges RE and SE in a network, RE being an existing 10,000 line exchange

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of the non-decimal revertive impulse control Ericsson type using 500-point power drive selectors throughout and SE being a 10,000 line exchange of the decimal direct-setting Strowger type which it is desired to interwork with the revertive exchange and which is assumed to employ 100-point selectors throughout.

Fig. 2 shows the basis of the numbering arrangements assumed to be employed in the revertive exchange RE for the various group and final selector ranks which will be required.

Fig. 3 shows the circuit of an outgoing "revertive to step-by-step" relay set at exchange RE together with its associated converter hunter uniselector switch.

Figs. 4–9, when arranged in the manner shown in Fig. 10 which is located at the foot of Fig. 9, show the circuit of a "revertive to step-by-step" converter at exchange RE.

Figs. 11 and 12 when arranged side by side with Fig. 11 on the left show the circuit of an outgoing "step-by-step to revertive" relay set at exchange SE.

Figs. 13 and 14 when arranged side by side with Fig. 13 on the left show the circuit of an incoming "step-by-step to revertive" relay set at exchange RE together with its associated translator hunter switch.

Figs. 15–18 when arranged in the manner shown in Fig. 19 which is located at the foot of Fig. 18, show the circuit of a "step-by-step to revertive" translator at exchange RE.

The revertive exchange RE is assumed to form part of a five-digit linked numbering scheme within which the step-by-step exchange SE has to operate, and assuming that the subscribers' numbers 90,000–99,999 are allocated to exchange RE and that the 80,000 group is not already used in the linked numbering scheme, the numbers 80,000–89,999 can be allocated to the exchange SE.

Referring firstly to Fig. 2, in the exchange RE there are twenty groups of 500 lines each, the groups being numbered 90,000–90,499, 90,500–90,999 . . . 99,500–99,999. Each selector has twenty-five multiple frames or levels of twenty outlets each, the levels being selected by a rotary motion and an outlet in a level being selected by a radial motion. First and second group selector ranks are provided, 1RGS and 2RGS1 being respective examples of such selectors. The various levels of the first selectors may give access to outlets to twenty-five different 10,000 line exchanges, a particular level 8 giving access to the exchange RE second selector rank. Twenty levels are utilised on the second selectors each giving access to outlets to twenty different final selectors. The final selector RFS is one of the rank serving the subscribers 90,000–90,499 and is accessible from level 1 of the second group selectors. Nineteen other ranks of final selectors are provided and serve the nineteen subscribers' groups 90,500–90,999, . . . 99,500–99,999, access thereto being provided over levels 2–20 respectively of the second group selectors.

The rotary movement of all selectors, which may involve up to 25 steps, is directed by what is usually termed a register, while radial movement along any selected level, which may involve up to 20 steps, is automatic in the case of group selectors and is directed by the register in the case of final selectors. The direction of the selector by the register is performed by means of revertive impulses sent back by the selector to the register and corresponding in number to the number of steps the selector moves. The reception of these revertive impulses in the controlling part of the register enables the register to stop the selector movement after the requisite number of steps has been made in accordance with the number dialled.

The number of steps made by the selectors is related to the number dialled in the following manner. If the number 90499 is dialled into the register, it will be seen from Fig. 2 that the register will need to direct the first group selector 1RGS to level 8 in response to the first digit "9," the second group selector 2RGS1 to level 1 in response to the second and third digits "04," the final selector RFS to level 25 in response to the third and fourth digits "49" and then over this level to position 20 in response to the last two digits "99." Access to any one of the 10,000 subscribers is thus had over three ranks of selectors.

The above remarks may be summarised as follows:

Dialled decimal digits, 9—0—4—9—9
Revertive non-decimal digits, 8—1—25—20

Referring now to Fig. 1, each of the twenty groups of 500 subscribers on the exchange RE is served by a rank of 500-point line finder switches adapted to perform a rotary search of up to 25 steps for a calling level followed by a radial search of up to 20 steps for a calling line in that level.

If subscriber RS1 originates a call, he will be connected over line finder RLF and associated register hunter switch RH to the register R and will then receive dial tone. The receiving and registering part of the register then receives the digits dialled, say 90499, for a local call and the controlling part of the register directs the setting of the first and second group selectors 1RGS and 2RGS1 and the final selector RFS to connect with the called party RS2 having the number 90499, the various selectors being positioned as described in connection with Fig. 2.

In the exchange SE the numbering follows a straightforward decimal basis. If a subscriber SS1 originates a call, he will be connected over line finder SLF or over an individual hunter switch to a first group selector 1SGS and will then receive dial tone. Assuming that the required subscriber SS2 has the number 80499, the first digit "8" will be effective on the first group selector 1SGS to raise its wipers vertically to level 8 after which hunting takes place in a rotary direction over the ten outlets to the rank of second group selectors which give access to ten groups of 100 lines each on the exchange.

Assuming second group selector 2SGS1 is taken into use, the second digit dialled which is "0" will cause its wipers to be raised to the tenth level after which it will perform a rotary search for one of a rank of third selectors serving the 1000 line group in which the called party is situated. The third digit dialled is effective on a group selector such as 3SGS to select the particular 100-line group and a final selector such as SFS then selects the particular subscriber SS2 in that group in response to the dialling of the last two digits 99.

Considering now the interlinking arrangements between the two exchanges, junctions from exchange SE to exchange RE are taken from level 9 of the first selectors. Assuming subscriber SS1 wishes to gain access to subscriber RS2 having the number 90499, the dialling of the first digit 9 will gain access to an outgoing junction relay set such as SORS, the other end of the junction being terminated on the incoming relay set RIRS which has associated therewith an incoming second group selector 2RGS2 and also a hunter switch TH. It will be understood that the incoming selectors such as 2RGS2 are added in exchange RE when arrangements are made for interworking with exchange SE. On the seizure of the relay set RIRS, the hunter switch TH connects it with a free translator T, the function of which is similar to that of the register R in that it has to direct the positioning of a non-decimal selector train in response to dialled decimal digits. The remaining four dialled digits of the required number are repeated by relay set SORS through to the incoming relay set RIRS. In the latter relay set an electromechanical impulse storage and regenerating device of the type disclosed in Patent No. 2,188,461, granted January 30, 1940, to John W. McClew et al. is provided so that if the impulses are received before a free translator has been found, the digits can be stored. As soon as a free translator is found, the regenerator sends out the stored trains of impulses through to the translator. As fully described in the specification referred to, the regenerator comprises essentially a receiving arm and a sending or transmitting arm which are carried on opposite sides of a plate carrying a circular row of pins. The receiving arm is rotated step-by-step in response to incoming impulses and carries with it a marking lever which is released at the end of each train of received impulses and which thereupon pushes a pin corresponding to the digit dialled through the pin plate into the path of the sending arm. For each digit received a corresponding pin is pushed through the plate and these pins serve to determine the movement of the sending arm which controls the generation of outgoing impulses.

When the translator has received the first two of the four decimal digits, it causes the second group selector 2RGS2 to commence to operate to pick out a free final selector in the appropriate 500-line group. The translator controls the setting of the second group selector 2RGS2 and final selector RFS by breaking the drive circuits of these selectors when the correct number of revertive impulses have been received therefrom, this being done in the same general manner as is done by the register R but in this instance by the use of standard relays and uniselectors. When the selectors have been positioned, the translator is released and becomes available for another call. The ringing of the called party's bell is effected from the final selector RFS and on the reply of the called party, this selector provides a transmission feed and at the same time returns a signal over the test wire of the connection to the incoming relay set RIRS which as in usual decimal system practice returns a reverse battery answering signal back over the junction line to exchange SE to bring about operation of the calling subscriber's meter by means of positive battery potential applied back over the test lead P from the outgoing relay set SORS.

Assuming now that subscriber RS1 wishes to connect with subscriber SS2 having the number 80499, the full five digits will be dialled into the register R. From Fig. 2 it will be seen that multiple frame or level 7 of the first selector banks is occupied by trunks leading to the ten thousand numbers of the exchange SE, and the selector is therefore directed to this level and then searches over the level to find a free outgoing relay set such as RORS, Fig. 1. On the seizure of the relay set RORS, the associated hunter switch CH connects with a free converter C. The converter sends back revertive impulse trains which are counted and interrupted by the register R as though the call were being completely set up on revertive selectors, and then sends forward to the decimal selectors of exchange SE corresponding decimal impulse trains which operate the second, third and final selectors at this exchange to route the call to the wanted party SS2. The register and converter are then released and become available for other calls. Ringing and transmission feed to the called subscriber are provided by the exchange SE final selector SFS which also transmits back an answering signal to the revertive exchange, the signal being received on relay set RORS which on the subsequent release of the connection, initiates the transmission of a metering signal back over the revertive exchange connection to meter the call against the calling party.

It will be appreciated that a number of step-by-step and revertive exchanges could be interlinked together in similar manner, it being only necessary to allocate appropriate selector levels at the various exchanges for the interconnecting junction lines.

Considering now the detailed operation of the various interworking circuits and referring firstly to Fig. 3 which shows the circuit of an outgoing relay set such as RORS, Fig. 1, this is taken into use by the application of earth to the test wire *c* from the first group selector IRGS in response to the dialling of a first digit 8. Relay JT operates and at contacts JT1 completes a self-interrupted driving circuit via the magnet interrupter contacts CHMC for the magnet CHM of the converter hunter uniselector CH so that the wipers CH1—CH6 are rotated from the position they are already occupying in seach of a free converter which will be marked by resistance battery potential over an SW lead extending to bank CH3. When one is found, relay K rapidly operates over its two windings in series and thereupon at contacts K1 extends a guard earth via its 20-ohm winding on to the outlet seized while at contacts K3 it brings up relay KA. This thereupon switches the incoming leads *a* and *b* through over wipers and banks CH1 and CH2 into the converter C, the outgoing junction negative and positive leads being also switched through to the converter via wipers and banks CH4 and CH5 and a circuit being prepared for relay SZ.

The converter subsequently proceeds to send out decimal trains of impulses over the junction to set up the step-by-step selector train in exchange SE, and when all trains have been sent out, relay SZ is operated via the SZ lead and bank and wiper CH6 and thereupon locks up and at contacts SZ4 opens the converter seizing circuit so as to release it for further common use, while at the same time it releases relays K and KA in turn to switch the incoming leads *a* and *b* through to the junction. Relay I operates when contacts SZ1 and SZ3 close in series with the line relay at the distant end of the junction and at its contacts I1 energises the polarising winding of shunt field relay D which is not operative in this condition. It will be seen that during the slow release of relay KA magnet CHM is reenergised so that when relay KA releases the switch CH will advance its wipers to the next position so as to give cyclic allocation of converters.

When the called subscribed at exchange SE answers, "called subscriber answer" supervision is received from the final selector in the usual form of battery reversal over the junction, whereupon the shunt field relay D operates and repeats the signal to the revertive equipment by applying earth at its contacts D1 to the incoming *c* lead, this earth serving to hold relay JT independently of the *c* lead.

Conversation now proceeds, the revertive exchange calling subscriber being supplied with battery feeding current from the line finder in usual manner while the called party's battery feed is supplied from the step-by-step exchange final selector.

At the end of conversation, if the calling party clears first, relay JT is held from contacts D1, while if the called party clears first relay JT is held over the "*c*" lead from the line finder. When both parties release, relays JT and SZ release in turn and the outgoing relay set is freed for further use, while the junction holding loop is opened at contacts SZ1 and SZ3 to release the selector train at exchange SE. In accordance with the usual practice of the revertive exchange, the line finder proceeds to meter the call against the calling subscriber.

Referring now to Figs. 4–9, the converter circuit shown which corresponds to C, Fig. 1, is adapted to revert three non-decimal digits to the register from which it is seized and to send out four corresponding decimal digits which may or may not be preceded by an additional prefix decimal digit according to the interworking arrangements concerned. In the present instance where the revertive exchange trunks into second group selectors at a five-digit step-by-step exchange, no prefix digit needs to be sent, and to secure this method of operation terminals 12 and 13, Fig. 6, are strapped.

The converter is taken into use over the SW lead from the converter hunter CH and thereupon relay T, Fig. 4, operates and brings up relay TA, Fig. 7, which opens the various homing circuits. The idle marking battery normally applied to the SW lead via the winding of relay T in parallel with the series-connected resistor AYB and magnet SSM, Fig. 5, extends via the home position of the digit distributor DD and the uniselectors VG, VV and RV associated with revertive impulse sending so that after having been taken into use and set into operation the converter will remain guarded until all these uniselectors have been restored to normal.

As soon as the register R, Fig. 1, is ready to receive revertive impulses, relay SR, Fig. 4, is operated over the "*b*" lead and brings up relay PR,

Fig. 8, which energises both the VG uniselector magnet VGM, Fig. 7, and relay RP, Fig. 9. At the same time relay RS (Fig. 7) is operated and this prepares a circuit for the magnet DDM of the distributor switch DD. Relay RP in operating, at its contacts RP2, Fig. 4, applies earth to the "*a*" lead extending back to the register, this constituting a revertive impulse, so that the revertive impulse receiving switch in the register will advance one step.

On the energisation of magnet VGM its interrupter contacts VGMC, Fig. 8, open and relay PR then releases slowly and de-energises the magnet whereupon the VG switch wipers are advanced one step from the home position 1 to position 2. The release of relay PR also operates relay RQ, Fig. 9, in series with relay RP which holds and so maintains the revertive earth impulse extending back to the register over the "*a*" lead.

When the VG switch wipers reach position 2, the contacts VGMC re-make and relay PR re-operates so as again to energise magnet VGM. Relay PR now holds relay RQ over its upper winding but releases relay RP which thereupon removes the earth potential from the "*a*" lead and this causes the register revertive impulse switch to take a second step, revertive impulses to the register normally comprising alternate makes and breaks of an earthed direct current circuit. Contacts VGMC in opening a second time again release relay PR which thereupon releases relay RQ, relay RP remaining normal at this time. Relay PR in releasing, also de-energises magnet VGM to advance the VG switch wipers a second step to position 3.

This sequence of operations, with the register receiving switch advancing step-by-step slightly in advance of the converter VG switch, continues until a marking in the register is reached in accordance with the second digit dialled, whereupon the battery potential which holds relay SR over the "*b*" lead is removed. Relay SR thereupon releases and at contacts SR2, Fig. 8, prevents any further re-operation of relay PR which will be in process of releasing at this time due to the opening of contacts VGMC. On the release of relay PR, the VG switch will make the final step so as to bring the number of steps it has made into line with those made by the register receiving switch. Relay SR also at contacts SR1, Fig. 7, completes an energising circuit for the distributor magnet DDM and at the same time opens the circuit for relay RS which commences to release slowly. On the release of relay RS, magnet DDM is de-energised and the wipers of switch DD are advanced one step from the home position to position 2 thus connecting up the revertive impulse interaction circuit to the second uniselector VV.

The setting up of this switch under the overriding control of the register via relay SR follows in similar manner to that of switch VG and subsequently the third switch RV is set in the same way. Switch DD advances one step after the setting of each revertive impulse sending switch so that its wipers will be set to position 4 after switch RV has been set.

It will be seen from Fig. 2 that if it had been possible for a connection from say subscriber RS1, Fig. 1, to subscriber SS2, No. 80499, on exchange SE to be set up over 500-line selectors, the first and second group selectors and the final selector would have had to be directed respectively to positions 7, 1 and 25.20 to gain access to the wanted party. In the present instance the first group selector 1RGS is used in the connection and is therefore directed to level 7 by the register, while the second group selector which would have been taken into use has an equivalent in the form of switch VG in the converter as far as its rotary motion is concerned, the automatic radial motion being of no interest since this is not directed by the register. For the final selector switch the two switches VV and RV in the converter are respective equivalents of the rotary and radial motion. In response to the signalling back of the revertive impulse trains 1, 25 and 20 from the converter, switches VG, VV and RV are therefore set to positions 2, 1 and 21 respectively, and it now remains to consider the conversion of the three non-decimal settings of these switches into the four trains of decimal impulses 0, 4, 9 and 9 which are necessary to select the required line 80499 on the exchange SE.

Since switch VG is positioned in accordance with the required 500-line group out of the twenty such 500-line groups, it can therefore determine the required 1000-line group out of the ten such groups. Switch VV is positioned in accordance with the required 20-line group out of the twenty-five such 20-line groups in the selected 500-line group and therefore in order to determine the 100-line group in the selected 1000-line group the positions of both switches VG and VV must be taken into account. Similarly, with regard to the third decimal digit to be transmitted, this can be determined from the combined positions of switches VV and RV, while in the case of the fourth decimal digit, this can be determined from the position of switch RV only. The first train of decimal impulses can thus be sent as soon as switch VG has been positioned, the second when switch VV is positioned and the third and fourth when switch RV is positioned, the digit distributor switch DD being used to control the sending out of these four trains.

It will be remembered that on the initial seizure of the converter, relay TA is operated by relay T at contacts T1. In response to the operation of relay TA, at contacts TA6, Fig. 6, the sending switch SS is caused to self-drive over the first portion of its bank to position 13, since as previously mentioned terminals 12 and 13 are strapped. The SS switch remains in this position until the first revertive digit 1 has been sent back to the register and when this has been done as indicated by the advancement of the DD switch wipers one step to position 2 the switch VG will have been set accordingly to position 2. A circuit is then completed from earth over wiper and bank DD2, Fig. 7, contacts TA3 and CO7, and bank and wiper SS7 to bring up relay MC, and also via wipers and banks DD2, SS7 and SS5, Fig. 4, to wiper VG2. In the present instance, since wiper VG2 is in position 2 and the first digit to be sent out is 0, no marking earth is applied to the common marking leads 1—9 via wiper and bank VG2 but the requirements are taken care of by the fact that earth representing the 0 digit marking is permanently connected to the sending switch banks SS1 and SS2, Fig. 5, which connect with these leads. Relay MC in operating brings up relays IP, Fig. 5, and RC, Fig. 6, and also energises the regenerator marking magnet MM, Fig. 9, whereupon the regenerator receiving arm is tilted clear of the circle of pins in readiness for storing a train of impulses on the regenerator. Relay IP in operating brings up relay IS, Fig. 8, which is without direct effect at this time, while relay RC in operating, at contacts RC1, Fig. 6, energises the sending switch magnet SSM and at contacts RC2, Fig. 9, energises the regenerator receiving magnet RM which in attracting its armature opens its interrupter contacts RMC and thereafter holds in series with resistance AYA. This method of magnet operation increases the speed of operation and release of the magnet. Magnet SSM in energising, at its contacts SSMC, Fig. 6, opens the circuit of relay RC which releases slowly and opens the circuits of magnets SSM and RM, whereupon the SS switch wipers and the regenerator receiving arm are both advanced one step.

This operation is then repeated and the wipers of switch SS and the regenerator receiving arm are advanced step-by-step in synchronism until the marked contact 23 is reached by wiper SS1 after ten steps have been made. Relay ST thereupon operates and at contacts ST1 disconnects the circuit for relay RC, while at contacts ST3, Fig. 7, it releases relay MC. This relay thereupon at contacts MC1, Fig. 9, de-energises the marking magnet MM so as to cause a pin to be displaced by the receiving arm to provide a mechanical marking corresponding to digit 0. At contacts MC2, Fig. 6, a self-interrupted driving circuit is completed for magnet SSM so as to rotate the SS switch wipers round to the next starting position, namely, position 26, relay ST holding during this time over contacts ST2 and its right-hand winding. At contacts MC3 Fig. 5, the circuit of relay IP is opened and it commences to release slowly.

As soon as the receiving arm of the regenerator left its initial position, the off-normal contacts N, Fig. 9 were closed but without any immediate effect. However, when the marking magnet MM is de-energised, the magnet interrupter contacts MMC in closing complete an operating circuit for relay BY, Fig. 9. This relay thereupon locks up at its contact BY1 independently of the contacts MMC, at contacts BY2 completes a circuit for the slow-to-operate relay MD from earth via a pin such as CDP left displaced after the regenerator was last used, the resetting pin RSP which is carried on the sending arm, and the sending magnet contacts TMC, and at contacts BY5 completes a holding circuit for relay IP. Relay MD in operating opens the holding circuit of relay IP and thereupon after the slow release of this relay and also of relay IS which is dependent on relay IP, the sending magnet TM is energised over contacts BY4 and IS1. Thereupon the pin in the regenerator which was displaced to mark the termination of the last train of impulses involved in the previous call is pushed out of the path of the regenerator sending arm and back to its normal position by the resetting pin RSP. However, owing to the stepped head on the pin as indicated diagrammatically in the drawing, the sending arm is not immediately released, but remains held until magnet TM is released. Magnet TM at its contacts TMC opens the circuit of relay MD which releases slowly and then in turn re-operates relays IP and IS, whereupon magnet TM is released and the sending arm is therefore freed and allowed to rotate under spring control until the reset pin RSP comes up against the stop pin which has just been set by magnet MM to indicate the termination of the first train of ten impulses. During this rotation of the sending arm the regenerator impulsing springs 33% M, Fig. 5, are interrupted at standard speed and serve to send out ten impulses over the outgoing negative and positive leads extending by way of the converter hunter CH and the junction line to the incoming selector 2SGS2, Fig. 1, in the step-by-step exchange SE.

During the reception of the digit 0 by the regenerator the sending out of the second train of twenty-five revertive impulses and the corresponding setting of the switch VV through 25 steps back to position 1 may be taking place. Hence during the sending out of digit 0 by the regenerator, sending switch SS will have been started up from position 26 to advance step-by-step to the decimal marking corresponding to revertive digit 25 and will therefore have transmitted an equivalent number of impulses to the regenerator receiving magnet RM. Accordingly, at the end of the sending out of digit 0 from the regenerator, relay BY will not release, since the off-normal contacts N will have remained operated. Moreover, relay MD will re-operate when the resetting pin RSP engages the first displaced pin and at contacts MD1 releases relays IP and IS slowly in turn to provide an interdigital pause between outgoing decimal digits from the regenerator. On the release of relay IS, sending magnet TM is again energised to initiate the sending out of the second decimal digit stored on the regenerator and similar remarks apply in regard to the third and fourth decimal digits.

For completeness of description however it will be assumed that the register is sufficiently slow in calling for the reception of successive revertive digits from the converter that the regenerator has time to send out each stored digit before it receives a further digit. Under these conditions the regenerator resetting pin RSP, on engaging the pin which was mechanically displaced to mark the digit 0, will terminate the first outgoing impulse train and thereupon since no further impulses have been received by the receiving magnet RM, the off-normal contacts N will open and so will release relay BY which at contacts BY2, Fig. 9, prevents relay MD from re-operating. At this time the switch SS will be occupying position 26 awaiting the positioning of switch VV in response to the sending out of a revertive train of 25 impulses to the register. When the last-mentioned impulse transmission is completed, switch VV will be returned to position 1 and the DD switch will advance its wipers to position 3 in readiness for the positioning of the final switch RV. On the advancement of the DD switch wipers to position 3, a circuit is completed from earth at contacts T1, Fig. 9, wiper DD5, Fig. 8, in position 3, bank SS8 and wiper in position 26, bank SS6 Fig. 5 and wiper in position 26, wiper VG3 Fig. 4 in position 2 and wiper VV2 in position 1 to marking lead 4. At the same time an operating circuit is completed over part of the same path for relay CO which thereupon locks over its left-hand winding and at contacts CO4, Fig. 7, brings up relay MC. Thereupon, as previously described, relays IP and IS are re-operated, the regenerator marking magnet MM is re-energised and relay RC is caused to interact with the sending switch magnet SSM so that the wipers of switch SS and the regenerator receiving arm are advanced step-by-step in synchronism until the marked contact 30 is reached by wiper SS2 after four steps have been made. Relay ST thereupon operates and opens the SS magnet interacting circuit and at the same time releases relay MC, whereupon the mechanical marking corresponding to digit 4 is effected on the regenerator and the SS switch is caused to self-drive via bank and wiper SS4 to the next starting position 38. On the de-energisation of the marking magnet, relay BY is again operated to initiate the sending out of the decimal digit 4.

When the register calls for the revertive impulse train 20, switch RV is set to position 21, after which the DD switch advances the wipers to position 4. Earth is then extended forward via wiper DD4, Fig. 8, in position 4, bank SS8 and wiper SS8 in position 38, wiper SS6 in position 38, wiper RV3 in position 21 and wiper VV5 in position 1 to earth the marking lead 9. Relay MC is released on the operation of relay ST when the SS switch finds the marking corresponding to digit 4 and remains normal when relay ST releases after switch SS has completed its self-interrupted driving operation to position 38, since the previous operating circuit therefor is now disconnected at wiper and bank SS8. Switch DD, however, on advancing to position 4 again completes an operating circuit for relay MC via wiper and bank DD4, bank and wiper SS8 and contacts CO4 and ST3. Relay MC in operating now initiates the advancement of switch SS from position 38 in search of the marking earth on lead 9, and the switch SS wipers and the regenerator receiving arm are again advanced step-by-step in synchronism until the marked contact 47 is reached by wiper SS2 after nine steps have been made. Relay ST again operates to release relay MC and magnet MM and thus effect a mechanical marking corresponding to digit 9, and the sending out of this digit by the regenerator proceeds to take place.

As before, the switch SS now self-drives from position 47 to the next starting position 1, after which relay ST releases. In this instance, since the final decimal digit 9 can be determined by the position of switch RV only, the SS switch on reaching position 1 now completes a re-operating circuit for relay MC from earth via contacts T1, wiper DD4 in position 4, contacts CO3, bank SS7 and wiper SS7 in position 1 and contacts ST3, while at the same time the earth extends via wiper SS5 in position 1, contacts CO2 and wiper RV2 in position 21 to again earth marking lead 9. Hence during the sending out of the penultimate digit 9, the SS switch will again be set in operation from position 1 to advance step-by-step to the marking on position 10 corresponding to digit 9, so that the final digit 9 will be stored on the regenerator during the sending out of the previous digit 9. Relay BY will therefore hold operated when the penultimate digit 9 has been sent out from the regenerator and relay MD will be operated to initiate the release of relays IP and IS to provide an interdigital pause, after which the sending magnet TM will be energised to initiate the sending out of the final digit 9.

When this has been effected and the switch SS reaches position 13 in its homing operation, relays BY, IP and IS will release in turn and a circuit is completed for relay ES, Fig. 6, via wiper SS3 in position 13, and contacts CO5, BY3 and IP2. Relay ES is operating, at contacts ES1, Fig. 5, introduces resistor AYC into the outgoing loop to prepare for the switching in of the supervisory relays at the outgoing relay set RORS, and at contacts ES2 extends an earth over the SZ lead to this relay set so as to operate relay SZ therein and bring about removal of the holding earth on lead SW. In response to the removal of the holding earth from the lead SW, relay T releases and thereupon releases relay TA, whereupon homing circuits are completed to cause the various switches to advance their wipers

through to their home positions. During this time the converter remains guarded due to the absence of battery potential on the incoming SW lead and is only marked free when all the switches DD, VG, VV and RV have reached their home position. It will be noted that since switch DD only moves four steps each time the converter is used it may be provided with five home positions.

In case the revertive exchange worked into first selectors on the step-by-step exchange or into second selectors on a six-digit step-by-step exchange, a prefix digit in addition to four corresponding decimal digits would have to be sent. The circumstances would generally be such however that for junctions incoming to the step-by-step exchange from the revertive exchange, the incoming selectors would have to be raised to a predetermined level to give access to the local selector ranks. In such circumstances the first digit of the five decimal digits to be sent out from the converter at the revertive exchange would be predetermined in accordance with the particular junction with which the converter was associated, while the remaining four digits would be determined in accordance with the number dialled by the calling party. The automatic transmission of a predetermined prefix digit from the converter can readily be provided by strapping terminals 10 and 11, Fig. 7, instead of terminals 12 and 13, Fig. 6, and by strapping terminal TTM, Fig. 4, to the appropriate one of the marking terminals 1—9. In this case it will be seen that on the operation of relay T on the seizure of the converter, earth is extended via contacts T1, Fig. 9, terminals 10 and 11, contacts CO3, bank SS7 and wiper SS7 in position 1 and contacts ST3 to bring up relay MC, while the earth will also be extended over wiper SS5 in position 1, and contacts CO2 to terminal TTM. Relay MC in operating in the usual manner initiates the storage of the prefix digit on the regenerator after which this is retransmitted as before to the step-by-step exchange. The storage and retransmission of further decimal digits will subsequently be under control of the register in the previously-described manner in accordance with the particular digits dialled.

Referring now to Figs. 11 and 12 which show the circuit of an outgoing relay set such as SORS, Fig. 1, this is essentially a decimal impulse train repeater with booster battery metering facilities. It differs from normal decimal impulse repeaters in that at the conclusion of conversation it allows the calling exchange SE subscriber to clear from the connection but thereafter guards the junction until the revertive exchange called subscribed has cleared and the revertive exchange equipment has restored to normal. This is necessary, since the revertive exchange operates on a last party release basis, while the step-by-step exchange operates on a calling party release basis.

The junction guard condition is initiated from the revertive exchange by the application of battery to the positive junction lead at the incoming relay set RIRS, Fig. 1. The application of battery potential to the positive lead may be effected either by battery reversal due to the called subscriber still being on the line or by separate application of battery to the positive lead as is usual on the revertive exchange in question under either premature release conditions where the calling party hangs up after dialling only part of the required number, or under artificial busy conditions where, for example, the incoming selector 2RGS2, Fig. 1, at the revertive exchange is artifically busied, say during maintenance routine, in which case the associated incoming relay set RIRS would be likewise rendered busy by the application thereat of a battery to the incoming junction positive conductor.

Considering now the circuit operation, when the relay set is seized, relays A, B, J, JA and BMD operate in turn. Relay A in operating extends a seizing loop via relays BD and BI across the outgoing junction, relay BI operating under this condition and serving to polarise relay BD which does not now operate. Relay B at contacts B1 guards the incoming P lead and at contacts B4 disconnects the guard relay G from the positive junction conductor and prepares a circuit for relay BB.

Relay A responds to the first train of impulses received from the calling SE exchange subscriber and on its first release it short-circuits relay B and removes the short-circuit from relay C which operates in series with resistor BYB, while at contacts A2 it opens the loop to the distant exchange. Relay C in operating brings up relay CA and also short-circuits relays BD and BI to provide an impedance-free impulse repeating loop. Relay CA in operating brings up relay BB which locks independently of contacts CA1. On the re-operation of relay A, relay B is re-energised and relay C is short-circuited, these two relays being intermittently short-circuited in turn during the remainder of the train and holding operated during this time.

At the end of the train, relays C and CA release slowly in turn and successively introduce resistor BYC and relays BD and BI into the outgoing junction loop, this method of introduction of the supervisory relays into the loop preventing the distant impulse-responding relay from momentarily releasing during the change-over due to the impedance of the supervisory relays.

Further trains of received impulses are repeated to the distant revertive exchange in similar manner, in response to which connection is ultimately effected with the called party.

When the called party replies, the feeding battery supplied to the junction conductors at the distant incoming relay set RIRS is reversed and relay BD thereupon operates and at contacts BD2 opens the circuit for relay BMD. On the release of relay BMD, a circuit is completed for relay DD from earth via contacts BD2 or JA4, JA3, C4, BB4 and BMD1. Relay DD in operating locks directly via its contacts DD1 to the contacts BD2 or JA4 and at contacts DD2 and DD3 reverses the battery back over the incoming speaking conductors for particular use when the calling party is a manual board operator. At contacts DD5 it opens the holding circuit of relay J which commences to release slowly, while at contacts DD6 booster battery potential is applied via protective resistor BYA and contacts JA5, DD6 and B1 to the incoming P lead for metering purposes. On the release of relay J, relay JA is restored to normal and at its contacts JA5 serves to terminate the booster battery metering pulse. Rectifier MRA serves to maintain guarding earth potential during the transit time of contacts DD6 and JA5.

At the end of conversation, if the calling party hangs up first, relays A, B and BB release in turn, but relays BD and BI remain held over the outgoing junction via contacts A2 and BD1. Hence on the release of relay B, relay J is re-operated via contacts DD4 and B3 and brings up relay BMD via contacts J2 and B2. This thereupon at contacts BMD2 maintains earth on the incoming P lead until such time as relays BD and BI are released in response to the clearing of the called subscriber.

Should the called party hang up first, relays BD and BI will release and in turn release relay DD, whereupon relay BMD will re-operate though without any effect in this instance. Relays A, B, BB and BMD thereupon remain held until the subsequent clearing of the calling party, whereupon the relay set and associated junction line are freed for further use.

Under any of the junction guard conditions mentioned earlier, it will be seen that the application of battery potential at the revertive exchange to the positive junction conductor will bring up relay G which thereupon brings up relay BMD to maintain a guarding earth on the incoming P conductor at contacts BMD2.

Referring now to Figs. 13 and 14 which show the circuit of an incoming relay set such as RIRS, Fig. 1, on the seizure of this relay set by a loop extended forward over the junction from the outgoing relay set SORS, Fig. 1, relay CA operates and brings up relay CB in series with the receiving magnet CRM of the relay set impulses regenerator, magnet CRM being inoperative in this condition. Relay CB in operating, at contacts CB2 extends an earth forward on the *c* lead via relay CD to the incoming selector 2RGS2, Fig. 1, whereupon relays CD and CG operate but without effect at this time. At contacts CB4 an operating circuit is completed for relay CBB, which operates and at contacts CBB2 connects relay CK to the test wiper TH3 of the translator hunter switch TH, at contacts CBB3 completes a self-interrupted driving circuit for the hunter switch magnet CTHM, and at contacts CBB5 prepares an operating circuit for relay CC.

For the purpose of the description, it will be assumed that while hunting for a free translator by switch TH is in progress, the first incoming digit is received by the relay set. Relay CA in responding thereto, on its first release short-circuits relay CB and removes the earth shunt from relay CC which thereupon operates in series with resistor CYC, while at the same time an energising circuit is completed for the regenerator receiving magnet CRM from earth via contacts CB1, CA1, CBB4, CSZ6, CRMC and magnet CRM to battery. Magnet CRM in energising opens its interrupter contacts CRMC and thereupon holds in series with the paralleled resistors CYA and CYB. Relay CC in operating, at contacts CC1 energises the regenerator marking magnet CMM which functions to tilt the receiving arm as previously described in connection with the converter regenerator, and at contacts CC2 brings up relay CIP which in turn operates relay CIS. On the reoperation of relay CA, relay CC is short-circuited, while an energising circuit is again completed for relay CB in series with magnet CRM which now releases and thereupon advances the regenerator receiving arm one step. The receiving arm is advanced step-by-step in response to subsequent impulses of the train, relays CB and CC holding operated during this time in the usual manner.

If during this time the hunter switch TH finds a free translator, which is marked by battery potential over the SW lead extending to bank TH3, relay CK will rapidly operate over its windings in series and thereupon applies a guard earth via its 20-ohm winding to the outlet seized, disconnects the magnet driving circuit, and brings up relay CKA which switches various leads through via the TH wipers to the translator and also at contacts CKA2 prepares an operating circuit for relay CBY.

At the end of the received incoming digit, which will be the thousands digit of the number dialled, relays CA and CB remain held, while relay CC releases slowly. On the release of relay CC, the marking magnet CMM is released, whereupon at contacts CMMC an operating circuit is completed via the operated regenerator off-normal contacts CN for relay CBY. Relay CBY in operating, at contacts CBY1 locks up independently of contacts CMMC which will be again operated when the next incoming digit is received, at contacts CBY2 prepares an energising circuit for the regenerator sending magnet CTM, at contacts CBY3 completes an energising circuit for the slow-to-operate relay CMD via the transmitting contact CTMC and the reset pin CRSP in contact with the coding pin CCDP displaced when the regenerator was last used, and at contacts CBY5 renders the continued holding of relay CIP dependent upon contacts CMD1. On the operation of relay CMD, relays CIP and CIS release slowly in turn, whereupon at contacts CIS2 an energising circuit is completed for the sending magnet CTM. Contacts CTMC thereupon open and release relay CMD, whereupon relays CIP and CIS re-operate and at contacts CIS2 the circuit for magnet CTM is opened. The regenerator sending arm is then freed and rotates under spring control until the reset pin CRSP comes up against the stop pin which has been set on the release of the marking magnet CMM at the end of the first incoming digit. During this rotation of the sending arm, the regenerator impulse springs 66% M are interrupted at standard speed and serve to send out a train of so-called "magnet" impulses, corresponding to the loop impulses received, via contacts CBY4 and CKA3, wiper and bank TH1 and the impulsing lead IMP, through to the thousands digit receiving magnet in the translator.

During the sending out of the train of impulses over lead IMP, the hundreds digit may be received on the regenerator receiving magnet. When at the end of the first re-transmitted digit the reset pin CRSP engages with the code pin displaced to mark its termination, a circuit is again completed for relay CMD which thereupon as before opens the circuit of relay CIP. On the release of relay CIP, relay CIS commences to release slowly and during its release time an earth is extended via contacts CIP1, CIS1 and CKA6, wiper and bank TH2 and lead DD to energize the magnet of the distributor switch in the translator. On the release of relay CIS, the translator distributor switch magnet is de-energized and advances its wipers one step to connect up the hundreds receiving magnet to the impulse lead IMP. If relay CBY is still operated at this time, thus indicating that the hundreds digit has been or is being received, the sending magnet CTM is again energized and thereupon releases relay CMD which re-operates relays CIP and CIS. Relay CIS in turn releases magnet CTM so as to initiate the sending out of the received hundreds digit over lead IMP to the hundreds receiving magnet of the translator.

In this manner all the various received digits are stored on the regenerator and re-transmitted thereby to the translator, relays CIP and CIS serving in the usual manner to provide an interdigital pause between outgoing digits.

When all received digits have been re-transmitted by the regenerator, the sending arm will catch up with the receiving arm and the off-normal contacts CN will then open and release relay CBY, which at contacts CBY2 prevents any further energization of the sending magnet CTM and at contacts CBY3 open the circuit for relay CMD.

In response to the reception of four decimal digits from the relay set, the translator will proceed to direct the revertive exchange switches into connection with the called party and when this has been done, the translator will apply earth to lead SZ to bring up relay CSZ. This relay in operating locks via its contacts CSZ2 to the earthed contacts CBB3, at contacts CSZ1 and CSZ4 disconnects any further circuit for relay CC, at contacts CSZ6 introduces resistor CYB into the impulsing circuit for magnet CRM to prevent further energization of this magnet on the subsequent release of relay CA when the calling party clears, at contacts CSZ3 and CSZ5 rearranges the circuit of relay CA without producing any immediate effect, and at contacts CSZ7 opens the circuit of relay CK which thereupon releases and in turn brings down relay CKA so freeing the translator for further common use.

When the called subscribed answers, a supervisory earth signal is returned over the "c" wire from the incoming selector 2RGS2, whereupon relay CD is shunted down, relay CG remaining held. Relay CD in releasing, at its contacts CD2 and CD3 returns reverse battery "called subscriber answer" conditions to the calling exchange.

At the end of conversation, if the calling party clears first, relays A, B and C release, but relay CSZ is held via contacts CSZ2 and CG2 in response to the earth fed back over the "c" wire to relay CG, which earth persists until the called party hangs up. The reverse battery condition is thus maintained over the incoming junction and during this time, as previously mentioned in connection with the outgoing relay set of Figs. 11 and 12, junction guarding conditions are maintained at the outgoing end.

During the release time of relay CBB after the calling party clears, the hunter switch magnet THM is energized so that on the release of relay CBB the TH switch wipers are advanced one step so as to give cyclic allocation of translators.

It will be noted that under the above-mentioned junction guard conditions since relay CSZ is operated, relay CA in releasing when the called party hangs up does not transmit a further impulse to the regenerator receiving magnet CRM. Under premature release conditions, however, magnet CRM is energised and relay CC operates in usual manner during this time and brings up relays CIP and CIS in turn. When relay CB releases, relay CD restores and relay CSZ operates via contacts CB2 and CIS3, thus reversing the battery to the incoming junction to give a junction guard condition as previously explained. On the release of relay CB with the regenerator in an off-normal condition, relay CBY is operated if it is not already operated at this time because the regenerator is sending out a previously stored digit. If no digits have been stored, relay CBY in operating will bring up relay CMD, whereupon the sending magnet CTM will be energised via contacts CB1 and CMD2 without waiting for the normal release of the interdigital-pause-determining relays CIP and CIS. On the energisation of magnet CTM, relay CMD is released, magnet CTM is de-energised and the regenerator proceeds to send the stored impulse into an open circuit since, by this time, relays CBB, CK and CKA will have released and thus will have opened any circuit to lead IMP at contacts CKA3. If any normal digits had been stored on the regenerator at this time, it will be seen that the release of the stored digits from the regenerator would have been performed at high speed, the normal interdigital pause being eliminated by the direct action of relay CMD with sending magnet CTM due to relay CB being normal. During the sending out operation, relay CIP is maintained via contacts CMD1 and CBY5 and so maintains relays CIS and CSZ so as to maintain the junction guard until the regenerator has sent out all its stored digits whereupon relay CBY will release and will release relays CIP and CIS in turn. If by this time the called subscriber is still holding on, relay CSZ will then remain held via contacts of relay CG which will be held to the "c" wire and the junction guarding will persist until the called party hangs up.

It should be explained that the incoming relay set includes a test jack (not shown) the two contacts of which extend respectively to earth and to the winding of relay CSZ. If the associated group selector is to be artificially busied, for instance while a maintenance man is working on it, a test link or plug is inserted into the test jack so as to connect the two contacts together. Relay CSZ is then operated and by reversing the connections of relay CA to the junction effects guarding at the outgoing end. It is also arranged that when the incoming relay set is removed from its supporting rack a pair of contacts automatically close whereby battery through a suitable resistance is connected to the positive line conductor, thereby preventing the taking into use of the junction at the outgoing end.

Referring now to the translator circuit of Figs. 15–18, corresponding to T, Fig. 1, this is adapted to receive four decimal digits from exchange SE via the incoming relay set RIRS and subsequently to receive three trains of revertive digits from the revertive exchange selectors during their setting to effect connection with the required party.

On the seizure of the translator, relay CK in the incoming relay set RIRS operates over lead SW, Fig. 15, in series with relay SA and resistor DYA in parallel over normal position contacts of the various uniselectors. Relay SA operates and at contacts SA3 brings up relay SB, at contacts SA4 locks independently of the various switch banks and wipers, and at contacts SA5 brings up the fast relay TR, Fig. 16. Relay SB in operating disconnects the homing circuits of the various uniselectors in the translator, while relay TR at contacts TR1, Fig. 18, causes switch RD to step to position 2. No further operations occur until two decimal impulse trains have been received over the IMP lead, Fig. 15, from the incoming relay set.

It will be noted that switches M, C, D, U and RD have two home positions 1 and 13, while switch DD has five home positions 1, 6, 11, 16 and 21, but it will be assumed for the purpose of the description that all switches are occupying position 1 when the translator is seized.

Assuming that the decimal trains to be sent out from the incoming relay set regenerator comprises digits 0, 4, 9 and 9, then in response to the first digit 0 which is effective on the thousands switch magnet MM, Fig. 15, the M switch wipers will be set to position 11 after which the distributor switch DD will advance its wipers to position 2 under control of the incoming relay set which, as previously described, applies an earth pulse to the DD lead after the sending out of each digit. In response to the subsequent digits 4, 9 and 9, the switches C, D and U will be set to positions 5, 10 and 10 respectively, while the DD switch will finally occupy position 5.

From reference to Figs. 1 and 2 it will be seen that in response to the reception of the digits 0, 4, 9 and 9 by the translator, in order to effect connection with the required party via the revertive exchange switches 2RGS2 and final selector switch such as RFS, the translator will need to direct the group selector 2RGS2 to level 1 in response to the first two digits "04," the final selector to level 25 in response to the second and third digits "49" and then over this level to position 20 in response to the last two digits "99."

When the first two digits "04" have been received by the translator, as indicated by the advancement of the DD switch wipers to position 3, the circuit for relay TR, Fig. 16, will be opened, whereupon at contacts TR1, Fig. 18, switch RD is advanced to position 3. In this position wiper RD2, Fig. 16, applies battery via resistor DYB to the "b" wire extending to selector 2RGS2 via the incoming relay set so as to start off its rotary movement towards its first position 1. At the same time wiper RD4, Fig. 16, applies earth over contact 3 and bank and wiper PG2 to advance the PG switch to its second position 2.

For each step the revertive selector makes it returns a revertive impulse back over the "a" wire to the translator, the impulses comprising alternate connections and disconnections of an earthed direct current circuit, connections indicating odd positions and disconnections indicating even positions of the selector. These pulses actuate relay RP, Fig. 16, which advances the PG switch one step for each operation and one step for each release of the relay. The PG switch is always slightly in advance of the selector so that when it picks up a marking corresponding to the first two decimal digits "04" it will be able to stop the revertive selector on the appropriate position 1.

In the present instance, as soon as the PG switch is advanced to position 2 relay PCO, Fig. 18, is operated over the following circuit: battery, winding of relay PCO, contacts RP1, wiper RD5 in position 3, wiper PG4 in position 2, bank M3 and wiper M3 in position 11, bank C3 and wiper C3 in position 5, contacts SB6 to earth. Relay PCO in operating, at contacts PCO1 locks independently of contacts RP1, at contacts PCO2 prepares a circuit for advancing switch RD from position 3, at contacts PCO3, Fig. 16, prepares to disconnect the selector driving circuit and at contacts PCO4 disconnects any further circuit for the PG switch magnet.

When the selector reaches position 1 appropriate to the decimal digits "04," it applies earth to the "a" lead so as to bring up relay RP, whereupon at contacts RP1, Fig. 18, relay PCE is operated from the marking earth which is applied via wipers and banks RD5, PG4, M3 and C3. Relay PCE in operating, at contacts PCE1 locks independently of contacts RP1, at contacts PCE3, Fig. 16, opens the selector driving circuit and at contacts PCE4, Fig. 18, advances the RD switch to position 4.

In case the first two digits dialled had been other than "04," the marking earth to bring up relays PCE and PCO would not have been reached until a number of revertive pulses had been received from the selector, this number corresponding to the first two digits as determined by the positioning of the thousands and hundreds digit receiving switches M and C.

When the RD switch reaches position 4, the circuit of relays PCE and PCO is opened and on the release of these relays, contacts PCO2 and PCE5 serve to step switch RD to position 5 where it remains until the third digit 9 has been received if this has not already occurred. The DD switch then steps to position 4 and thereupon releases relay TR, whereupon contacts TR1, Fig. 18, advance switch RD to position 6, and wiper RD2, Fig. 16, then re-applies battery to the "*b*" wire.

During this time the group selector will have searched for and found an idle final selector such as RFS and hence the potential on the "*b*" wire will start up the rotary movement of this switch. At the same time wiper RD4, Fig. 16, will advance switch VV to position 2. Revertive impulses which are returned over the "*a*" lead to relay RP are now effective on relay RP to step switch VV which, in similar manner to that already described in connection with switch PG, serves to stop the rotary movement when the final selector has executed the required number of rotary steps. In this instance the final selector requires to be stopped on level 25 and hence after switch VV has advanced 25 steps back again to position 1, relay PCO will operate over the following circuit: battery, winding of relay PCO, contacts RP1, wiper RD5 in position 6, wiper D3 in position 10, bank and wiper VV4 in position 1, wiper VV5 in position 1, contacts GD3, bank and wiper C4 in position 5, contacts SB6 to earth. Relay GD, Fig. 15, was operated when switch VV originally advanced from its home position 1, and serves to enable the home position of bank VV5 to be utilised for marking purposes. When the final selector completes its advance to position 25, relay PCE is then operated in response to the operation of relay RP and the selector rotary motion is thereupon halted by the removal of battery from the "*b*" lead. Relay PCE in operating advances the RD switch to position 7, whereupon relays PCE and PCO are released and switch RD is then stepped to position 8 where it remains until the fourth digit 9 has been completely received. When this occurs, the DD switch steps to position 5 and releases relay TR which thereupon advances switch RD to position 9.

Switch RD then initiates the radial movement of the final selector, switch RV operating under revertive control via relay RP and so controlling the final selector movement. When the required number of revertive steps (20) have been made, the radial movement is halted in similar manner to that already described for switch VV, the marking being in this instance communicated to relays PCO and PCE over wiper RD5 in position 9, wiper U3 in position 10, bank and wiper RV4 in position 20, wiper RV5 in position 20, and wiper D4 in position 10. After completion of the radial movement of the final selector, switch RD is advanced to position 13 and an "end of sending" earth signal is then applied to the SZ lead, Fig. 16, via contacts PCE2, PCO4 and RP2, wiper RD4 in position 13 and contacts GD2 to operate relay CSZ in the incoming relay set which thereupon frees the translator for further use by releasing relay SA, Fig. 15. Relay SA in releasing restores relays SB and GD and all the various switches in off-normal condition thereupon proceed to rotate their wipers to the nearest home position, the translator guarding itself against seizure during this time by virtue of the wipers and banks in circuit with the seizing relay SA.

We claim:

1. In a telephone system, an exchange operating on a direct setting decimal basis, an exchange operating on a revertive control non-decimal basis, switches in said exchanges, trunks between said exchanges, switch controlling registers at said non decimal exchange, an impulse storing and regenerating device at said non-decimal exchange, means at said non-demical exchange controlled from said switch controlling registers for transmitting impulses on a decimal basis to said device, rotatable mechanism in said device operable in response to said transmitted impulses thereto for mechanically storing said impulses and for thereafter regenerating and retransmitting said stored impulses over certain of said trunks to said decimal exchange for directively operating the switches thereat to com-non-decimal exchange to said decimal exchange, and impulse storing and translating means at said non-decimal exchange responsive to impulses on a decimal basis transmitted from said decimal exchange over others of said trunks to said non-decimal exchange for controlling the setting of the switches thereat to complete a connection in the opposite direction.

2. In a telephone system, a first exchange, a second exchange, a trunk between said exchanges, switches in said first exchange operating on a revertive control non-decimal basis, switches in said second exchange operating on a direct setting decimal basis, a register at said first exchange for controlling the switches thereat, a mechanical type impulse storage and regenerating device at said first exchange, means at said first exchange also controlled from said register at times for transmitting impulses on a decimal basis to said device, and rotatable mechanism in said device operable in response to said transmitted impulses thereto for mechanically storing said impulses and for thereafter regenerating and transmitting said stored impulses on a decimal basis over said trunk to said second exchange and operate the switches thereat to complete a connection from said first exchange to said second exchange.

3. In a telephone system, a first exchange, a second exchange, direct setting step-by-step switches in said first exchange, revertive control switches in said second exchange, registers in said second exchange for controlling the said switches thereat by means of revertive pulsing, trunks each comprising only two conductors extending between said exchanges, a mechanical type impulse storing and regenerative device associated with each said trunk at said second exchange, means for seizing one of said devices over the two conductors of the associated trunk from one of said direct setting switches to extend a connection, a finder switch for connecting an idle one of said registers to said seized device, means for passing decimal trains of impulses to said seized device over said trunk, means to permit said seized device to store the incoming pulses while said finder is hunting, and means to control the setting of said one register from said seized device in accordance with the impulses stored therein, said revertive control switches being controlled in turn from said register to complete the connection.

4. In a telephone system, a first exchange operating on a direct setting step by step basis, a second exchange operating on a different basis, revertive control switches in said second exchange, registers in said second exchange, a two-conductor trunk comprising only two conductors extending between said exchanges, an outgoing repeater in said trunk at said first exchange, a mechanical impulse storing and regenerative device in said trunk at said second exchange, means for transmitting trains of impulses on a decimal basis to said device through said repeater and said trunk to extend a call from said first exchange to said second exchange, said impulses being thereupon stored by said device, means for connecting said device to one of said registers and passing said stored impulses thereto to position said register, means to control the setting of said revertive control switches in turn from said register to complete the connection, and means in said outgoing repeater controlled over said two conductors of said trunk to maintain the trunk busy at the outgoing end until both parties to such completed connection have released.

5. In a telephone system, a first exchange operating on a step by step decimal basis, a second exchange operating on a revertive control non-decimal basis, switches in said second exchange, registers in said second exchange, a trunk between said exchanges, an outgoing repeater in said trunk at said first exchange, a mechanical type impulse storing and regenerative device at said second exchange, means for transmitting trains of impulses on a decimal basis to said device over said trunk to set said device in response to an interoffice call, means to position one of said registers in accordance with the setting of said device, means for revertively controlling said switches from said one register to complete the call between a calling party in the first exchange and a called party in the second exchange, a supervisory relay in said outgoing repeater operated in response to said called party answering, a locking circuit to maintain said supervisory relay operated prepared by said relay and completed should said calling party release first, and circuits controlled by said maintained supervisory relay for keeping a busy guard on said trunk at said first exchange until said called party also releases.

6. In a telephone system, a first exchange operating on a step by step decimal basis, a second exchange operating on a revertive control non-decimal basis, switches in said second exchange, a register in said second exchange, a trunk between said exchanges, an outgoing repeater in said trunk at said first exchange, an incoming repeater in said trunk at said second exchange, a mechanical type impulse regenerator in said incoming repeater, means for passing trains of impulses on a decimal basis over said trunk and through said repeaters during the establishment of an interoffice call to set said regenerator, means to set said register in accordance with the setting of said regenerator, means for revertively controlling said switches from said register in accordance with said register setting to complete the establishment of the call between a calling party in the first exchange and a called party in the second exchange, a relay in said outgoing repeater operated when said called party answers, means in said outgoing repeater effective in case the calling party should release first for maintaining said relay operated until the called party releases, means controlled by said maintained relay for keeping said trunk busy at the outgoing repeater, and other busying means including a relay in the incoming repeater at the second exchange which is maintained operated until the called party releases to maintain a potential on one of the trunk conductors.

7. In a telephone system, a first exchange operating on a direct setting decimal basis, a second exchange operating on a revertive control basis, switches in said exchanges, a trunk between said exchanges, conductors in said trunk, an outgoing repeater at said first exchange, an incoming repeater at said second exchange, a mechanical type impulse regenerator and a switch controlling register associated with said incoming repeater, means for passing trains of impulses on a decimal basis from a switch in said first exchange through said repeaters and said trunk during the establishment of a call from said first exchange to set said regenerator, means to set said register from said regenerator, means to revertively control the switches in said second exchange in turn from said register to complete the call, a busying relay in said outgoing repeater connected to one of said trunk conductors, a relay in said incoming repeater for connecting a given potential to said one conductor in response to the call being answered, means to cause the operation of said busying relay from said given potential if the calling end releases first, and another relay responsive to the operation of said busying relay to maintain a busy guard on said trunk at said outgoing repeater.

8. In a telephone system, a first exchange, a second exchange, a trunk between said exchanges, switches in said first exchange operating on a revertive control non-decimal basis, switches in said second exchange operating on a direct setting decimal basis, a register at said first exchange for controlling the switches thereat by means of revertive pulsing, a plurality of rotary type marking switches at said first exchange, a rotary type sending control switch and a mechanical type impulse storing and regenerative device at said first exchange, means for setting said marking switches in succession from said register by means of revertive pulsing on outgoing calls to said decimal exchange, means for marking said sending control switch with the decimal equivalents of said settings, means for stepping said sending control switch accordingly and passing corresponding decimal trains of impulses to said regenerative device, and means to cause said regenerative device to transmit corresponding trains of impulses over said trunk to said second exchange for operating the switches thereat.

9. In a telephone system as in claim 8, means for causing at least some of said marking switches to co-operate in pairs to determine the proper decimal markings for said sending control switch.

10. In a telephone system, a first exchange operating on a direct setting decimal basis, a second exchange operating on a revertive control non-decimal basis, a trunk comprising only two conductors extending between said exchanges, reversive control switches in said second exchange, a mechanical type impulse storing and regenerative device individual to said trunk in said second exchange, a plurality of rotary type marking switches in said second exchange, a plurality of rotary type register switches in said second exchange, means for passing trains of impulses on a decimal basis over said two conductor trunk to said device on interoffice calls

from said first exchange, means for passing said trains of impulses from said regenerator to said marking switches and for setting said marking switches in succession in accordance therewith, means for marking said register switches in accordance with said settings, and means for controlling said revertive control switches in succession from said register switches by means of revertive pulsing.

11. In a telephone system, a first exchange operating on a direct setting decimal basis, a second exchange operating on a revertive control non-decimal basis, revertive control switches in said second exchange, a trunk between said exchanges, an incoming repeater in said second exchange, a mechanical type impulse storage and regenerative device in said second exchange, a plurality of rotary type marking switches in said second exchange, a plurality of rotary type register switches in said second exchange, a line relay in said repeater, means for seizing said repeater and operating said line relay over said trunk on a call from said first exchange, means for passing trains of impulses on a decimal basis over said trunk, said line relay responding to said impulses and repeating said trains of impulses to said regenerative device, means for repeating said trains of impulses by said regenerative device to said marking switches and for setting said marking switches in accordance therewith, means for marking each said register switch in accordance with the setting of one or more of said marking switches, means for controlling said revertive control switches in succession from successive ones of said register switches by means of revertive pulsing in accordance with said marking means to extend the call, and means to prevent said line relay from passing an additional impulse to said regenerative device upon the final release of said line relay at the termination of the call.

12. In a telephone system, a first exchange operating on a direct setting decimal basis, a second exchange operating on a revertive control non-decimal basis, revertive pulsing switches in said second exchange, a junction connecting said

exchanges, a mechanical type impulse regenerator in said second exchange, marking switches in said second exchange, a distributor switch in said second exchange, register switches in said second exchange, a first control conductor for said marking switches and a second control conductor for said distributor switch extending from said regenerator to said distributor switch, means for repeating trains of impulses on a decimal basis from said first exchange over said junction, said regenerator responding to said impulses, means for causing said regenerator to repeat said trains of impulses to said marking switches over said first control conductor and to set said marking switches successively in accordance therewith, means controlled by said regenerator for stepping said distributor switch over said second control conductor during the interdigital pauses to connect said first control conductor to said marking switches in succession as required, means for marking said register switches in accordance with the settings of said marker switches, and a second distributor in said second exchange for controlling said revertive pulsing switches from successive ones of said register switches in accordance with said markings.

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