April 26, 1932. J. E. OSTLINE 1,855,727

TELEPHONE SYSTEM

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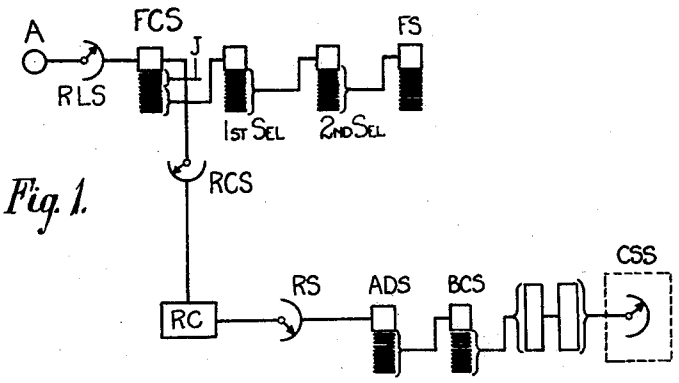


Fig. 1.

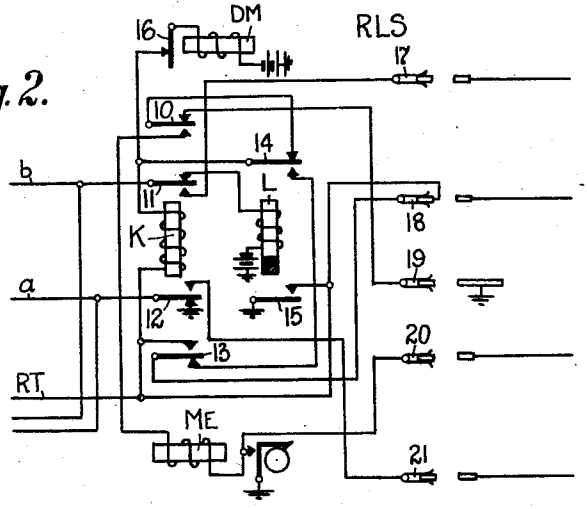


Fig. 2.

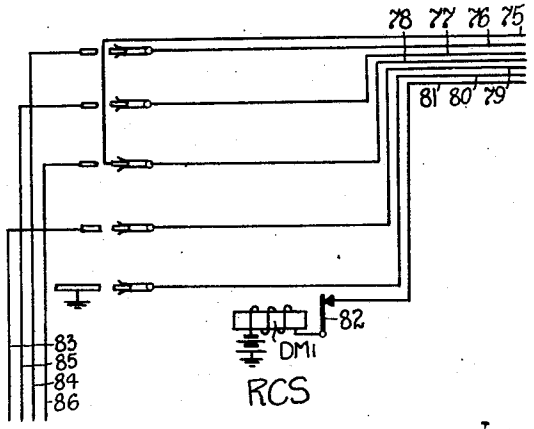


Fig. 4.

Inventor
John Ellis Ostline

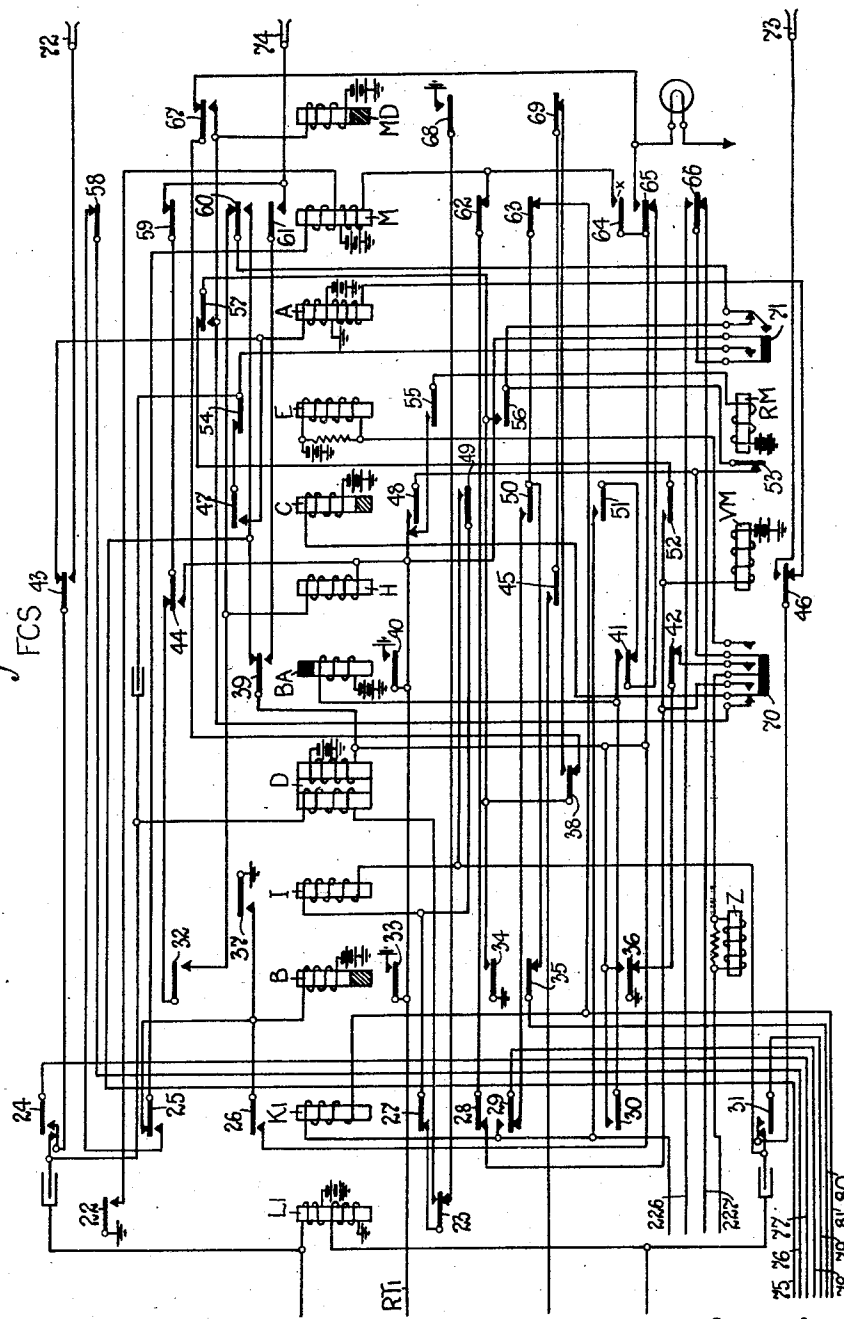
R. B. Richardson Atty.

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Fig. 3.



Inventor
John Ellis Ostline
Atty.

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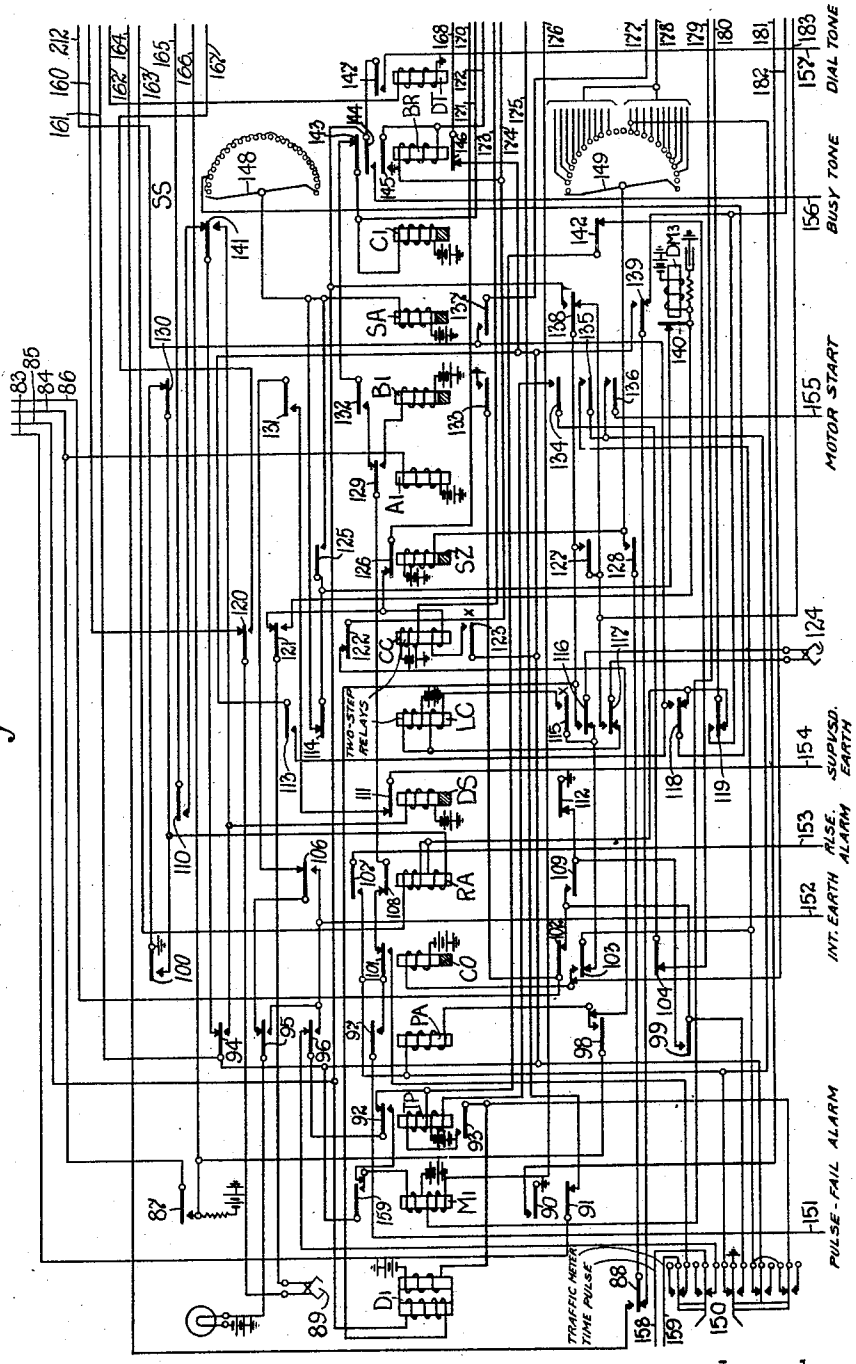


Fig. 5.

Inventor
John Ellis Ostline
By R. S. Richardson Atty.

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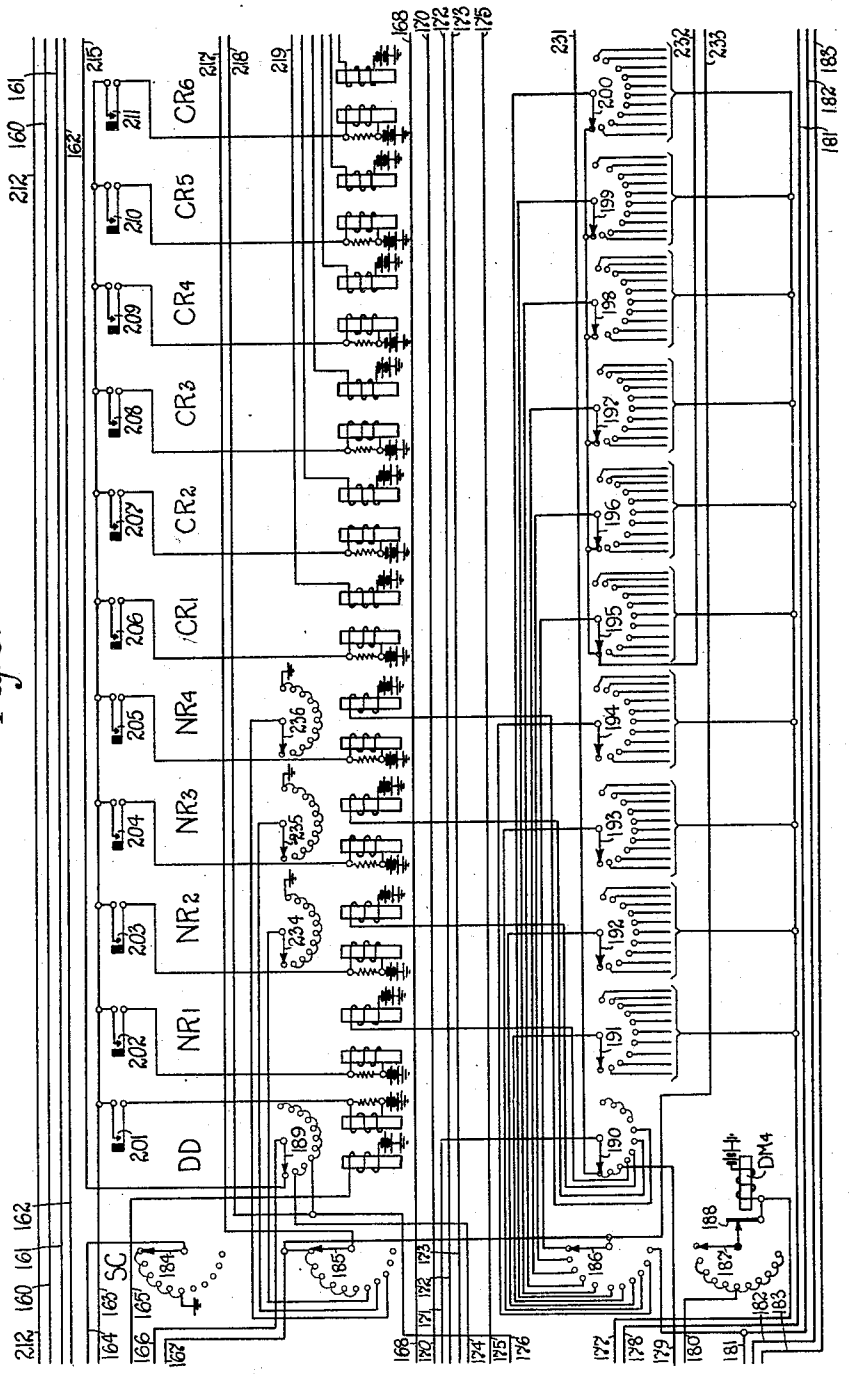


Fig. 6.

Inventor
John Ellis Ostline
R. B. Richardson Atty.

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Fig. 8.

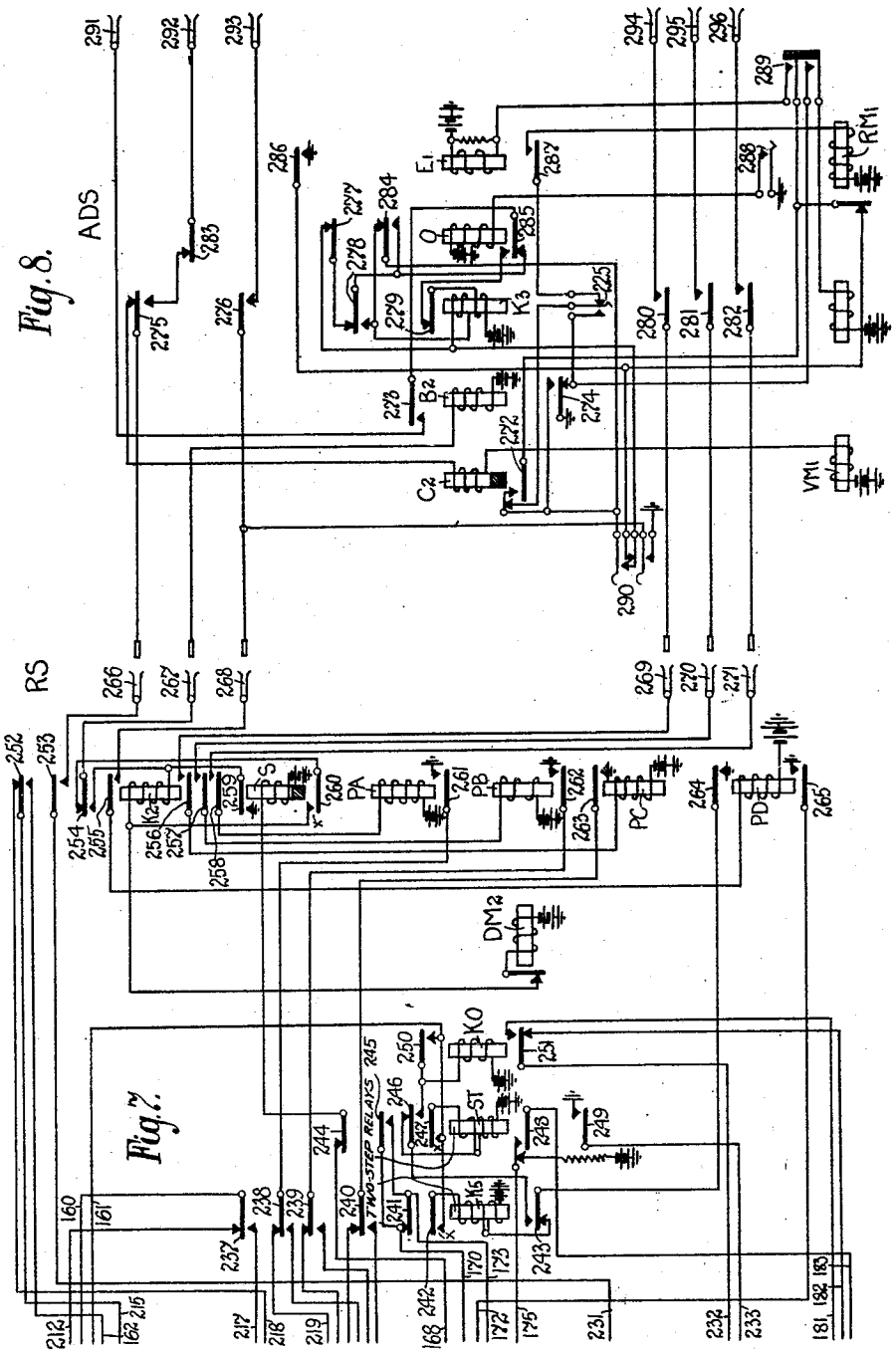


Fig. 7.

Inventor
John Ellis Ostline
By Richardson Atty.

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Fig. 10.

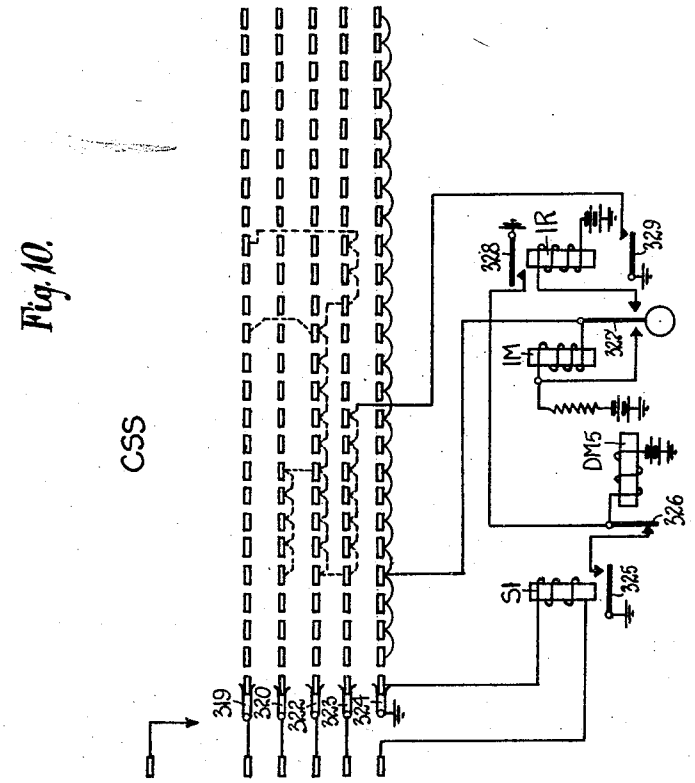
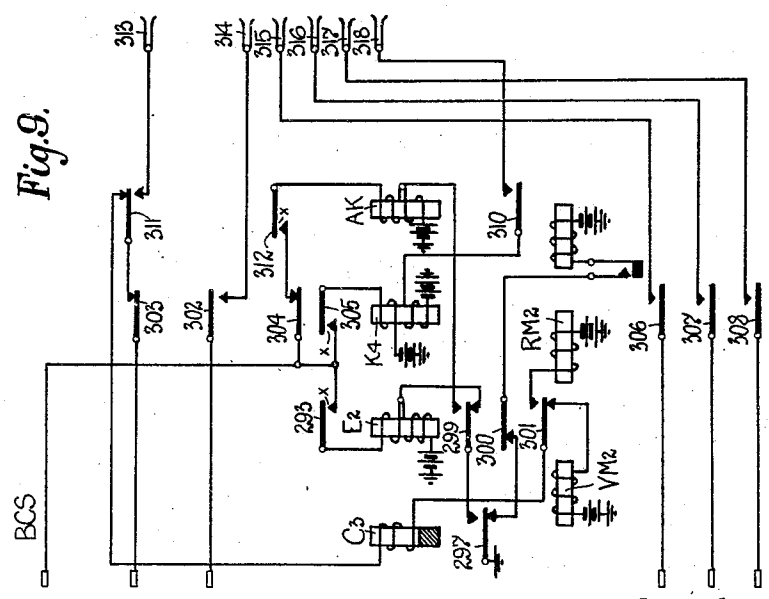


Fig. 9.



Inventor
John Ellis Ostline

R. B. Richardson Atty.

Patented Apr. 26, 1932 1,855,727

UNITED STATES PATENT OFFICE

JOHN ELLIS OSTLINE, OF LIVERPOOL, ENGLAND, ASSIGNOR TO ASSOCIATED TELEPHONE AND TELEGRAPH COMPANY, OF KANSAS CITY, MISSOURI, A CORPORATION OF DELAWARE

TELEPHONE SYSTEM

Application filed October 1, 1928, Serial No. 309,610, and in Great Britain October 14, 1927.

The present invention relates to improvements in automatic or semi-automatic telephone systems and more particularly relates to register controller systems such as disclosed in my Patent 1,724,142, granted Aug. 13, 1929.

In the arrangement there shown an impulse sending device was provided individual to each exchange. This sending device was common to a group of register controllers and was arranged when selected by switches responsive to the exchange digits dialled to send the exchange code digits back to the register controller over a single lead and corresponding to the route over which calls to that exchange are to be set up. The code digits were each represented by impulses sent in code to reduce the sending time. Such coded impulses were arranged to operate apparatus in a register controller which recorded them, and then controlled the transmission of the uncoded impulses of the exchange code to effect the routing of a call to the required exchange. The apparatus by which the coded impulses were recorded consisted of relays and a special translating device was necessary in view of the fact that the impulses received were in code.

One of the features of the present invention is that the impulses sent by the common impulse sending device to the register controller are not in code and that they are recorded directly on single directional switches.

Another feature of the invention is that in order to reduce the waiting time required for the impulse sender to get to the beginning of a cycle, the duration of a cycle is reduced by arranging that a plurality of series of impulses are transmitted simultaneously over separate leads. For instance, three series of impulses may be transmitted in one stage and be followed by three more series of impulses in the second stage. This enables the number of steps of the impulse sender to be reduced while at the same time, the time during which the impulse sender can operate through a complete cycle is also reduced.

Another feature of the invention is that the register controller does not include any apparatus for registering the exchange digits dialled by a calling subscriber. The register controller, moreover, includes uni-directional switches only. Access is had to the common impulse sending device over one or two ranks of switches, according to the number of exchange digits to be dialled. In the case of three exchange digits the first digit is registered on a two-directional switch, which then hunts to find an idle two-directional switch adapted to respond to the next two digits and to thereupon associate itself with an impulse sender corresponding to the exchange required.

These and other features of the invention will be better understood by referring to the accompanying drawings, in which Fig. 1 is a trunking diagram, Fig. 2 shows a usual homing type rotary lineswitch, Fig. 3 shows a battery feed selector, Fig. 4 shows a register controller selector of similar construction to the rotary lineswitch of Fig. 2, Figs. 5, 6 and 7 show the apparatus in the register controller RC and also the register selector RS, Fig. 8 shows an "A" digit register, Fig. 9 shows a "B" and "C" digit register and Fig. 10 shows a code sending switch.

In order to facilitate the understanding of the invention the drawings should be placed with Fig. 3 to the right of Fig. 2 when the conductors between Figs. 2 and 3 and Figs. 3 and 4 will be found to be in alignment. Fig. 5 should be placed below Fig. 4 with Figs. 6, 7, 8, 9 and 10 to the right of Fig. 5 in order. All conductors between the various figures will be found to be in alignment and the layout thus obtained gives a complete through circuit of the essential apparatus and equipment of the registering and controlling device and associated circuits.

The above features, and others not specifically mentioned, will be better appreciated from the following description of the actual operations which take place when a connection is set up.

This arrangement, however, is given by way of an example only, since it will be apparent to those skilled in the art, that the principles of the invention are capable of a

wider application than to the precise arrangements shown.

A description will first be given, therefore, of a connection between a calling subscriber A and a wanted subscriber B in another exchange, whose number we will assume to be HOLborn 6607.

When the subscriber at station A removes his receiver, line relay L operates over conductors *a* and *b*. Relay L, upon operating, earths the release trunk conductor RT at armature 15, and at armature 14 completes the following circuit for the driving magnet DM: Earth, battery, driving magnet DM, interrupter springs 16, armature 14 and front contact, armature 13 and back contact, private wiper 18 and its associated bank contact front contact and armature 15 to earth. By this operation the rotary lineswitch RLS is advanced from home position into engagement with the first set of bank contacts and assuming that the set shown is idle, switching relay K will operate in series with the driving magnet DM in the following circuit: battery, driving magnet DM, and its interrupter springs 16, winding of relay K, front contact and armature 15 to earth. Relay K energizes in this circuit and extends the speaking conductors *a* and *b* at armatures 11 and 12 over wipers 17 and 21 to the winding of the impulsing relay L1 of the first code selector FCS shown in Fig. 3.

Switching relay K also prepares a circuit at armature 10 for the meter ME which will be described later, and completes a locking circuit for itself at armature 13.

Relay L1 upon operating completes the following circuit for guard relay B; earth, armature 22 and front contact, upper low resistance winding of forced release relay M, armature 25 and back contact, winding of relay B to battery. Relay B energizes in this circuit and connects earth to release trunk conductor RT1, over armature 33, thereby providing a holding circuit for switching relay K before line relay L of the rotary line switch de-energizes. Impulse accepting relay A energizes in the following circuit: earth, lower winding of relay A, back contact and armature 46, make spring controlled by armature 31, winding of relay I, armature 27, armature 23 and front contact, left-hand winding of relay D, make spring controlled by armature 24, armature 43 and back contact, upper winding of relay A to battery. Relay A energizes in this circuit and completes a circuit for relay C as follows: earth, armature 34 and front contact, armature 57 and front contact, off-normal springs 70, winding of relay C to battery, and in a branch circuit energizes the meter delay relay MD, which locks energized over its own contacts and armature 38 of relay D. Relay C energizes in this circuit and prepares a locking circuit for itself extending over off-normal spring 70, armature 52, armatures 57 and 34, which circuit becomes effective when pulse relay A de-energizes, and also prepares a circuit for rotary relay E in readiness to complete the rotary circuit when the vertical impulses have been received.

At armature 36 and front contact relay B completes the following circuit for the driving magnet DM1 of the register controller selector RCS shown in Fig. 4; battery, winding of the driving magnet DM1, interrupter springs 82, conductor 81, armature 63, armature 50, armature 29, conductor 78, private wiper and home position of bank contacts in the register controller selector, conductor 75, back contact and armature 39, front contact and armature 36 to earth.

The register controller selector advances its wipers from the home position bank contacts to the first set of bank contacts. Should the register controller on which it is now resting be engaged, a circuit is completed for the driving magnet DM1 as follows: earth, conductor 86, bank contact and wiper of the register controller selector RCS, conductor 78, armature 29 and back contact, armature 50, armature 63, conductor 81, interrupter springs 82, winding of the driving magnet DM1 to battery.

The magnet operates and breaks its own circuit at the interrupter springs 82 thereby releasing and moving the wipers on to the next set of bank contacts. This operation is repeated until the wipers rest on the bank of an idle register controller, when no earth is connected to conductor 86. During this operation switching relay K1 cannot energize as it is short-circuited by earth on one side of its winding over armature 36, and front contact, armature 65 and back contact, armature 41 and back contact, armature 51 and on the other side of the winding by the earth picked up on conductor 86 over armatures 29, 50 and 63.

As soon as an idle register controller is connected with, a circuit is completed for switching relay K1 which energizes in the following circuit: earth, armature 36 and front contact, armature 65, armatures 41 and 51, winding of relay K1, conductor 81, interrupter springs 82, winding of driving magnet DM1 to battery. Relay K1 operates and switches the impulsing, guarding and holding leads (conductors 76, 77, 78, 79) through to the register controller shown in Fig. 5 over the wipers of the register controller selector.

The operation of switching relay K1 also completes an energizing circuit for auxiliary guard relay BA as follows: earth, armature 36 and front contact, armature 30, winding of relay BA to battery, guard relay B is now maintained energized over armature 26 of switching relay K1 and armature 36 to earth.

Impulse accepting relay A1 of the register controller shown in Fig 5 now operates in

the following circuit: earth, armature 22 and front contact, upper low resistance winding of relay M, armature 25 and front contact, armature 58, conductor 76, wiper of the register controller selector, conductor 84, winding of relay A1 to battery The circuit of guard relay B1 is now completed as follows: earth, springs on busy key 150, armature 101 and back contact, armature 108, armature 129 and front contact, winding of relay B1 to battery. The operation of guard relay B1 extends earth to conductor 86, over armature 133, wiper of register controller selector, conductor 78 to maintain switching relay K1 energized. This earth also guards the register controller selector from being seized by any other register controller selector.

The operation of relay B1 also earths the motor start lead 155, lights the supervisory lamp mounted on the register controller from the supervised-earth lead 155, and prepares an impulsing circuit for an A digit switch shown in Fig. 8 and B and C digit switch in Fig. 9. Relay S of the register selector in Fig. 7 is energized in the following circuit; earth, springs of busy key 150, armature 135, springs of busy key 150, armature 146, conductor 168, armature 244, winding of start relay S to battery.

Impulse relay A of the first code selector FCS is maintained energized in the following circuit: earth, lower winding of relay A, back contact and armature 46, make spring controlled by armature 31, conductor 79, wiper of register controller selector, conductor 83, armature 91, conductor 175, break spring controlled by armature 248, resistance to battery

The register selector switch shown in Fig. 7 is resting on contacts connected to an A digit switch ADS Fig. 8, and if the A digit switch is already in use earth is connected to the bank contact over wiper 267 as explained below and this earth is extended over armatures 254 and 260, interrupter springs, rotary magnet DM2 of the register selector to battery. The rotary magnet DM2 energizes and breaks its own circuit at the interrupter springs thereby releasing and moving the wipers on to the next set of contacts. If the A digit switch connected to these contacts is also in use, the above operation is repeated until an idle "A" digit switch is found i. e. when no earth is picked up by wiper 267.

During the rotation of the register selector RS, the switching relay K2 is short-circuited by earth from wiper 267 over armatures 254 and 260 on one side of its winding and earth over armature 259 on the other side. As soon, however, as wiper 267 rests on a free contact, switching relay K2 operates in the following circuit; earth, armature 259, winding of relay K2, interrupter springs, winding of rotary magnet DM2 to battery. The rotary magnet does not operate in the circuit due to the high resistance of the switching relay K2.

Earth over armature 259 is extended to winding of relay B2 to battery, over back contact and armature 254, wiper 267 and bank contact. This earth also guards the A digit switch ADS from other register selectors which may be hunting.

The dial tone relay DT now operates in the following circuit: earth, winding of relay DT, conductor 162, armature 252, conductor 215, first contact and wiper 189 of the digit distributor switch DD, conductor 166, resistance to battery, and dial tone is transmitted to the calling subscriber, from dial tone, on conductor 157, armature 147, conductor 35, bank contact and wiper of register controller selector RCS, conductor 77, armature 24 of switching relay K1, armatures 43, 47 and 54, tone condenser, line condenser, bank contact and wiper 17 of the subscribers rotary line-switch, armature 11 of switching relay K, *b* line to the calling subscriber.

On hearing the dial tone, the subscriber will commence to dial the office or exchange digits followed by the required subscribers numerical digits. While the operations outlined above i. e. the finding of the A digit switch were being performed, two-step relay LC in the register controller energizes in the following circuit: earth, spring of busy key 150, armature 135 and front contact, armature 103 and back contact, back contact and armature 116, loop pulse springs 124, armature 117 and back contact, upper winding of relay LC to battery. Relay LC operates, firstly its armature 115 thereby completing a locking circuit for itself as follows: earth, springs of busy key 150, armature 135 and front contact armature 103, armature 115 and front contact, both windings of relay LC in series to battery.

The operation of relay LC also prepares the circuit for connecting the loop pulse springs 124 across the conductors 83 and 85 as soon as the register controller is ready to send out impulses, and also completes the circuit for the two-step relay CC. The two-step relay CC energizes in the following circuit: earth, springs of busy key 150, armature 135, busy key 150, armature 113, conductor 212, armature 237, conductor 160, back contact and armature 120, pulse springs 89, armature 121 and back contact, armature 126, conductor 170, armature 241, conductor 173, upper winding of relay CC to battery.

Two step relay CC first operates to close its armature 123 and as soon as the magnet pulse springs break operates fully to close all its springs, being now maintained energized in the following circuit: earth, springs of busy key 150, armature 135, springs 150, armature 123, lower winding of relay CC, armature 126, conductor 170, armature 241, conductor 173, upper winding of relay CC to batttery.

The operation of the two-step relay CC prepared the circuit for the magnet pulsing springs and the sender switch driving magnet DM3 in readiness for the time when the register controller is prepared to send out pulses.

As the subscriber dials the first exchange digit, which in our example is "H", the numerical equivalent being 4, line relay L1 of the first code selector FCS will pulse in response to the motion of the dail.

This in turn will send impulses to relay A1 of the register controller RC, its circuit being broken at armature 22 of line relay L1 of the first code selector.

As the impulse relay A1 restores its completes a circuit for the vertical magnet of the A digit switch ADS from earth, springs of busy key 150, armatures 101, 108, 129, 132, 143, conductor 171, wiper 190 and 1st bank contacts of the digit distributor switch DD, conductor 231, armature 253, wiper 266 and bank contact of the register selector, armature 275 and its back contact, winding of series relay C2, winding of vertical magnet VM1 to battery.

Relay C1 of the register controller is also operated in this circuit in parallel with series relay C2 and vertical magnet VM1. The vertical magnet VM1 of the A digit switch ADS raises the wipers to the required level, in this case 4, while the series relay C2 being slow to release remains operated during the train of impulses.

The off-normal springs 289 close with the first vertical step, and the circuit for rotary relay E1 is now completed as follows: earth, armature 274, make springs controlled by armature 272, off normal springs 289, winding of interrupter relay E1 to battery. Relay E1 completes a locking circuit for itself over off-normal springs 289 the rotary interrupter springs to earth on armature 286 and prepares the circuit for the rotary magnet RM1. When relay C2 releases, the rotary magnet RM1 is energized from earth, armatures 274, and 272, springs 225, armature 287, winding of the rotary magnet RM1 to battery. The magnet operates, moves the wipers on to the first set of bank contacts, and opens the circuit of relay E1, which releases and breaks the rotary magnet circuit. If the B and C digit switch connected to the contacts on which the A digit switch is now resting is in use wiper 291 will be connected to earth, which is extended over armature 273, armatures 285 and 278 and 277, upper winding of relay L3, cam springs 290, rotary interrupter springs, off-normal springs 289, winding of relay E1 to battery. Relay E1 operates, completes the rotary magnet circuit which in turn operates and moves the wipers on one step and again releases relay E1.

As soon as the wipers rest on an idle B and C digit switch, switching relay K3 energizes in the following circuit: earth, armature 274, armature 284, upper winding of relay K3, cam springs 290, interrupter springs, off-normal springs 289, winding of relay E1 to battery. Relay E1 is however adjusted not to operate under these conditions. The operation of switching relay K3 switches conductors through to the B and C digit switch and also extends earth forward over armatures 274 and 284, armatures 278, 285 and 273 to wiper 291 to prevent the B and C digit switch from being seized by another A digit switch.

When shunt relay C1 in the register controller operates, it completes the circuit for the digit stepping relay DS, as follows: earth, busy key 150, armature 135, busy key 150, armatures 94, 141, winding of relay DS to battery. Relay DS energizes in this circuit and when relay C1 restores at the end of the first series of impulses, relay DS also releases. As however, relay DS is slow to release, a circuit is completed for the digit distributor DD, as follows: earth, busy key 150, armature 135, busy key 150, armatures 94, 141 and 110, conductor 165, stepping magnet of the digit distributor switch DD to battery. The magnet energizes and steps the wipers on to the next contacts, breaking the circuit of the dial tone relay DT which therefore releases. When the subscriber dials the second exchange digit (in our case "0"), the vertical magnet VM2 of the B and C digit switch will respond and raise the wipers to the "0" level, the impulsing circuit being the same as that outlined above and being extended through the "A" digit switch by the operation of the switching relay K3.

Series relay C3 operates in series with the vertical magnet VM2 and a circuit is completed for the lower winding of two step relay E2 as follows: earth, armature 297, and front contact, armature 299 and back contact, lower winding of relay E2 to battery. Relay E2 partially energizes in this circuit to operate armature 293. When relay C2 restores after the series of impulses two-step relay E2 operates fully in the following circuit: earth, armature 284 and front contact, armature 284 and back contact, front contact and armature 278, back contact and armature 285, armature 273 and front contact, wiper 291 and associated bank contact, front contact and armature 293, both windings of relay E2 in series to battery. Relay E2 switches the pulsing lead through to the rotary magnet RM2. In the register controller relay C1 operates in a parallel circuit with the vertical magnet VM2, and in turn operates the digit stepping relay DS. When shunt relay C1 restores, the circuit for stepping the magnet of the digit distributor switch is completed during the period of the slow release of relay DS.

When the magnet of the digit distributor

switch operates it steps the wipers to the next contacts.

The subscriber now dials the third exchange digit, which in this example "L" corresponds to the digit 5, and the rotary magnet RM2 of the B and C digit switch operates and steps the wipers to the fifth contact in the bank. The operation of relay C3 in series with the rotary magnet RM2 of the B and C digit switch energizes one winding of auxiliary switching relay AK and this relay first operates its armature 312. When series relay C3 restores at the end of the rotary impulse auxiliary switching relay AK operates fully in the circuit: earth on wiper 291, armature 304, armature 312, both windings of auxiliary switching relay AK in series to battery.

The operation of relay AK prepares the circuit for the switching relay K4. In the register controller RC shunt relay C1 operates during the impulses and operates stepping relay DS, in turn stepping the magnet of the digit distributor switch. This operation is as described previously.

It will now be seen that the impulsing lead is connected over the wiper of the digit distributor switch DD to the stepping magnet of the first numerical register switch NR1.

As the subscriber dials the numerical digits of the required subscriber's number, it will be readily seen that these are stored on the numerical register switches NR1, NR2, NR3, NR4, the operation of shunt relay C3 and distributor stepping relay DS stepping the magnet of the digit distributor switch after each series of impulses.

The numerical register switches, NR1, NR2, NR3, and NR4 will now be resting on contacts 6, 6, 0 and 7 respectively.

The dialling of the exchange digits connects the B and C digit switch to a certain set of bank contacts as explained above. A code sending switch CSS is connected to these contacts and this will now operate and send out the code required, which may consist of any number up to six digits.

It will be appreciated that the code sending switch CSS is sending the exchange code into the register controller and the register controller is beginning to send it out at the same time as the subscriber is dialling the numerical digits of the required subscribers number.

The circuit for the switching relay K4 is now completed as follows: battery, lower winding of switching relay K4, armature 310, of auxiliary switching relay AK, wiper 318 and bank contact of B and C digit switch, winding of relay S1, contact and wiper 324 of code sending switch CSS to earth. Switching relay K4 first operates its armature 305 thereby fully operating all its springs and locking energized over its second winding, start relay S1 also operates, completing a circuit for the driving magnet DM5 of the code sending switch. The operation of the switching relay K4 opens at armature 304 the circuit of relay AK allowing it to release. The driving magnet operates, breaks its own circuit at the interrupter springs thereby releasing and moving the wipers to the next set of contacts. Relay S1 now restores and the earth from the wiper 324 is connected to the impulser IM which may be of any well-known type and is shown in the drawing, for example, as of the vibratory type. The impulser IM will now cause relay IR to impulse and drive the rotary magnet DM5 at a predetermined speed. When the wipers have advanced a few steps, the wipers 320, 322, 323, will pick up earth from the strapping of the bank contacts which strapping is carried out in accordance with the required translation.

It will be noticed that the strapping is commenced on the fourth bank contacts and this ensures that by passing over the bank contacts the driving magnet is receiving impulses quite regularly before any pulses are sent out. The earth on the bank contacts is also supplied from the impulsing relay IR to ensure a consistent impulse ratio.

Let us suppose that the office letter combination HOL is to be translated to four code digits say 7053 these being the digits necessary to operate the various switches to route the call to the HOLborn office, it being understood that the routing may be through one or more intermediate offices depending on the trunking facilities.

From the drawings it will be seen that certain of the bank contacts of the code sending switch levels are strapped to earth on the contacts of the impulsing relay IR. The code sending switch to which connection is made by dialling HOL on the A digit switch and B and C digit switch has the contacts strapped in accordance with the translation required i. e. the level associated with wiper 323 has 7 contacts strapped to earth (and a little further along the bank another 3) the level with wiper 322 has 10 and that with 320 has 5, while connections are made to the bank of wiper 319 for switching purposes.

As the code sending switch wipers are driven round the bank under the influence of the impulser the wipers will pick up earth pulses. Wiper 323 will transmit seven impulses, wiper 322, ten, and wiper 320, 5 impulses to the pulsing relays PA, PB and PC respectively in the register controller. The circuit for pulse relay PA extends from earth, bank of code sending switch CSS, wiper 323, contact and wiper 317 of B and C digit switch, armature of switching relay K4, armature 308, contact and wiper 296 of A digit switch, armature 282, contact and wiper 271 of register selector RS, armature

258, winding of pulse relay PA to battery. The circuits for pulse relays PB and PC extend over wipers 315 and 316 in a similar manner.

Pulse relay PA energizes and in turn operates the stepping magnet of the code register switch CR1 from earth, armature 261, armature 238, conductor 219, stepping magnet of code register CR1 to battery. The stepping magnet of code register switches CR2 and CR3 are energized in a similar manner from pulse relays PB and PC, thus the code register switches CR1, CR2 and CR3 are now in position 7—0—5 respectively.

When the code sending switch reaches the 14th contact a pulse is transmitted over wiper 319, contact and wiper 314, armature 302, contact, and wiper 293, armature 276, contact and wiper 268, armature 255, winding of relay PD to battery. Pulse switching relay PD operates and energizes the lower winding of two-step relay K5 to firstly operate its armature 242. When relay PD restores, two step relay K5 operates fully, and is maintained energized from earth on busy key 150, armature 135, busy key 150, conductor 161, armature 242 of two step relay K5, both windings of relay K5 in series to battery.

The operation of two-step switching relay K5 prepares the circuit for relay ST and disconnects relay CC which therefore releases, and at the same time switches the pulsing conductors from code register switches CR1, CR2 and CR3 to code register switches CR4, CR5, CR6.

As the code sending switch wipers pass over the remaining bank contacts, wiper 323 will pick up three earth pulses which will be transmitted by the pulsing relay PA to the magnet of code sending switch CR4. The wipers 320 and 322 will not pick up any earth pulses and code register switches CR5 and CR6 will therefore remain in their normal positions.

After the required pulses are transmitted to the pulse relays wiper 319 picks up earth and this again operates pulse relay PD, a circuit being completed over armature 243 of relay K5 for the lower winding of the two-step start relay ST. Start relay ST firstly operates its armature 247 and when PD restores will operate fully and extend an earth from armature 249 to conductor 233, bank contact and wiper 185 of sender control switch SC, conductor 217, armature 237 of switching relay K5, conductor 160, armature 120, magnet pulse springs 89, armatures 121 and 126, conductor 170, armature 245, conductor 173, upper winding of two-step relay CC to battery. Two-step relay CC will firstly operate its armature 123, and when the magnet pulse springs break, will operate fully. The magnet of the sender switch is now connected in series with the magnet pulse springs to earth, the circuit extending as follows: earth, armature 249, conductor 233, conductor 167, conductor 167, armature 120, magnet pulse springs 89, armature 121, driving magnet DM3 of sender switch SS to battery. The sender switch wipers will now be driven round the bank at the rate of 10 contacts per second, which is the speed of the magnet pulsing springs.

The operation of relay ST also opens at armature 244 the circuit of relay S which is slow to release and when relay S has fully restored, it allows switching relay K2 to restore and also disconnects earth from wiper 267 allowing relay B2 of the A digit switch to restore.

As soon as relay B2 releases it removes the holding earth from switching relay K3, and also from wiper 291 allowing relays E2 and K3 to release. The release magnet circuits of the A digit switch ADS and the B and C digit switch BCS are now completed and these switches will therefore release and be available for further calls.

The operation of relay ST also removes battery from the relay A of the first code selector FCS but this relay is now maintained energized by the loop circuit extending over the shunt field relay D1 in the register controller, armature 138, conductor 183, armature 248, conductor 175 and armature 91.

In the register controller the sending switch is being driven round the bank by the magnet pulsing springs and a circiut is completed for start relay SA as follows: earth, busy key 150, armature 135, busy key 150, armatures 113 and 118, bank contact and wiper 148 of the sender switch SS winding of start relay SA to battery. The operation of start relay SA short-circuits the winding of the shunt field relay D1 and connects the loop springs 124 across the conductors to the first code selector FCS.

The loop pulse springs operate in conjunction with the magnet pulse springs and while the sender switch SS is being driven round the bank the loop pulse springs will open and close the loop to the first code selector FCS. The operation of start relay SA also completes the circuit of the sender control switch rotary magnet from earth, busy key 150, armature 135, busy key 150, armatures 113 and 137, conductor 177, winding of sender control switch SC driving magnet DM4 to battery. The magnet is held energized till start relay SA restores. When the sender switch is on the 8th contact (the loop pulse springs having been effective 7 times, as start relay SA operated on the first contact) a circuit is completed for relay SZ as follows: armature 249 of relay ST, conductor 233, wiper 186 and bank contact of sender control switch SC, wiper 195 and No. 7 bank contact of code register switch CR1, conductor 178, No. 8 bank contact and

wiper 149 of sender switch SS, winding of stop relay SZ to battery.

Stop relay SZ energizes in this circuit and immediately short circuits the loop pulse springs thereby preventing further impulses affecting the loop circuit. It also completes a holding circuit for itself over the operated contacts of relay SA from earth, busy key 150, armature 135 and front contact, busy key 150 front contact and armature 139 of relay SA, back contact and armture 88, armature 128 and front contact, winding of relay SZ to battery, and completes a homing circuit for the sender switch magnet from earth, busy key 150, armature 135, busy key 150, armatures 113 and 118, bank contact and wiper 148 of the sender switch, armature 125, interrupter springs 140, winding of driving magnet DM3 to battery. This circuit also maintains relay SA energized, while relay CC releases as its circuit is opened at armature 126.

The sender switch returns to its home position whereupon relay SA releases, opening the circuit of relay SZ which in turn releases. The loop across the loop pulse springs is now maintained over the winding of shunt field relay D1 and back contact of armature 138 of start relay SA.

The first series of impulses sent out from the register controller are received on the impulse accepting relay A of the first code selector FCS and these are sent to cause the shaft to be raised to the required level, which in the case under consideration is the seventh.

As the impulse accepting relay restores, a circuit is completed for the vertical magnet as follows: earth, armature 34, armature 57 and back contact, armature 52, vertical magnet VM to battery. With the first vertical step the off-normal springs 70 close and relay C is maintained operated in parallel with the vertical magnet. The vertical magnet raises the shaft to the 7th level at which point relay C releases. The rotary relay E operates as soon as the off-normal springs close and provides a locking circuit for itself over the rotary interrupter springs 53 and its own armature 56. When shunt relay C restores the rotary magnet is energized in the following circuit: earth, armature 33, make spring controlled by armature 48, armature 55, winding of rotary magnet RM to battery. The rotary magnet moves the wipers into engagement with the first set of bank contacts, and also opens the circuit of relay E at the interrupter springs 53. Relay E releases and in turn opens the circuit of the rotary magnet RM.

It will be understood that the levels of the first code selector are connected in some cases to local switches and in some cases direct to outgoing junctions. As our call is for a distant office the contacts of the seventh level will be connected to outgoing junctions.

If the junction on which the wipers are now resting is already in use, the wiper 74 will pick up earth which will be extended over armature 59, armature 44 and back contact, armature 32, back contact and armature 60, cam springs 71, rotary interrupter springs 53, off-normal springs 70, winding of rotary relay E to battery. Rotary relay E operates and again completes the circuit for the rotary magnet which operates, moving the wipers to the next contact bank and releasing relay E which in turn opens the magnet circuit. This sequence of operations is repeated until an idle junction is found, the winding of switching relay H being short-circuited throughout this operation.

As soon as an idle junction is found, switching relay H operates from earth, armature 33, winding of switching relay H, back contact and armature 60, cam springs 71, rotary interrupter springs 53, off-normal springs 70, winding of rotary relay E to battery. The rotary relay E is adjusted not to operate in series with switching relay H.

The operation of switching relay H extends earth to wiper 74, over armature 33, front contact and armature 44 and armature 59 to prevent the junction being taken into use by another first code selector and at the same time switches at armatures 43 and 46 the wipers 72 and 73 through to the loop pulse springs in the register controller. The succeeding impulse trains from the register controller will be received on switches in the distant office.

Impulse accepting relay A is released by the operation of switching relay H. It will be realized that before the register controller sends out the next impulse train the sender switch SS has to return to the home position and the stop and start relays SA and SZ have to release. Both these relays are made slow to release so that the pause between the sending of digit trains is ample to allow switching operations in other equipment to take place.

The releasing of start relay SA allows the magnet of the sender control switch SC to de-energize and thus move the wipers on one step.

The circuit for the upper winding of control relay CC is completed when stop relay SZ restores and control relay CC first operates its armature 123 operating fully over both windings in series as soon as the magnet pulse springs open. The operation of control relay CC again connects the magnet pulse springs in series with the driving magnet DM3 of the sender switch SS and the sender switch wipers move round the bank, start relay SA operating as they step on to the second contact and placing the loop pulsing springs across the conductors to the first code selector.

As switching relay H in the first code selector is operated the loop pulse springs 124 are

across the wipers 72 and 73, which are connected to an outgoing junction. Therefore, the pulses now being transmitted are effective to operate a switch situated in another office, and this switch will then automatically select idle trunks to further switches as necessitated by the trunking scheme.

When the sender switch wipers come opposite the 11th contact, wiper 149 will pick up an earth from armature 249, over conductor 233, wiper 186 and bank contact No. 2 of the sender control switch SC, wiper 196 and No. 11 bank contact of code register switch CR2, bank contact and wiper 149 of sender switch SS, winding of stop relay SZ to battery. Stop relay SZ operates and locks itself energized over contacts of start relay SA at the same time closing the loop across the pulsing springs, preventing further loop pulses being effective. The sender switch now returns to the home position and start relay SA releases and in turn releases stop relay SZ the loop being now maintained through one coil of the shunt field relay D. The magnet of the sender control switch SC which was energized by the operation of start relay SA restores as soon as start relay SA releases, and moves the wipers to the third set of contacts.

The code digits sent out by the register controller so far have been 7 and 0, and the remaining two code digits set up on the code register switches CR3 and CR4, i. e. 5 and 3 are sent out in an exactly similar manner, the sender control switch advancing one step each time.

These code digits 7053 being the ones necessary to route the call to the HOLborn exchange, the register controller will now send out the numerical part of the required subscribers number, i. e. 6607 these digits actuating the switches situated in the final exchange, in this case HOLborn.

After the sending of the digit 3, the sender control switch will be on the 5th contact and the earth is extended from armature 249, over conductor 233, wiper 186, and 5th bank contact of sender control switch SC, wiper 199 and contact 1 of code register switch CR5, conductor 232, armature 251 and back contact, conductor 182, front contact and armature 119, conductor 180, bank and wiper 187 of sender control switch SC, interrupter springs 188 winding of magnet DM4 to battery. The magnet operates and breaks its own circuit, thereby releasing and moving the wipers on to the next contact bank where it again finds earth, connected over wiper 200 and contact 1 of the code register switch CR6. The magnet therefore operates and again steps the wipers.

The earth is now connected from armature 294, over conductor 233, wiper 186 of the sender control switch to the bank and wiper 191 of the first numerical register switch NR1. The sender switch will again rotate, stop relay SZ operating in the circuit from earth over wipers 186 and 191, when 6 pulses have been sent. The remaining pulses of the required subscriber's number are sent in exactly the same manner as those previously described and the switches in the final office are actuated till they are connected to the required subscriber's number.

The sender control switch SC steps one between the sending of each digit and when the last digit has been sent it steps on to the 11th contact and completes a circuit for cut-off relay CO as follows: earth, armature 249, conductor 233, wiper 186, conductor 181, make spring controlled by armature 103 winding of cut-off relay CO to battery. Cut-off relay CO operates and locks energized over earth busy key 150, armature 135, busy key 150, armature 103, winding of relay CO to battery.

The operation of cut-off relay CO releases loop relay LC and also opens the circuit of guard relay B1 which is slow to release. It also completes a circuit extending over lead 163 for the several release magnets of the digit distributor switch DD, the number register switches NR1—NR4 and the code register switches CR1—CR6 over their associated off-normal contacts 201, 202—205, and 206—211 respectively. The meter circuit is now completed as follows: earth, busy key 150, armature 101 and front contact, busy key 150 to meter lead 159 to register for traffic purposes. A circuit is completed from earth, armature 100, lower winding of release alarm relay RA, armature 119, conductor 180, bank and wiper 186 of sender control switch SC, interrupter springs 188, winding of driving magnet DM4 to battery. The rotary magnet operates and the wipers are stepped to the home position.

The operation of release alarm relay RA completes the alarm circuit over conductor 153 which is brought into operation if any of the rotary magnets should not return the switches to the home position.

The register controller lamp flickers during the releasing of the switches, and in case of a fault indicates on which circuit the fault has occurred.

As soon as guard relay B1 has fully restored the earth is removed from the conductor 86, leaving the register controller available for use on other calls.

The removal of earth from conductor 86 allows switching relay K1 of the first code selector to restore. The restoring of relay K1 completes the circuit between calling subscriber and the switches in the train to the called subscriber.

As soon as the called subscriber lifts his receiver, in response to the call, shunt field relay D is operated, the direction of the battery through its line coil being reversed by the final switch in the train. The operation of shunt field relay D breaks the circuit for meter delay relay MD and after its slow

release period this relay will restore. A circuit is now completed from earth, armature 34, armature 38 and front contact, armature 69, armature 45, bank contact and wiper 20, winding of subscriber's meter ME, front contact and armature 10, back contact and armature 14, interrupter springs 16, winding of driving magnet DM to battery. The subscriber's meter ME operates and locks over its own contacts. The slow release time of meter delay relay prevents any possibility of the controller metering due to inductive kicks of the shunt field relay D.

On the completion of the conversation the calling subscriber hangs up his receiver opening the circuit of line relay L1 which restores and breaks the holding loop across wipers 72 and 73 allowing succeeding switches in the train to release.

The holding circuit for guard relay B is also opened and relay B releases, in turn releasing auxiliary guard relay BA. Earth is disconnected from wiper 18 of the subscriber's line switch allowing relay K to restore and complete the homing circuit for the rotary magnet from earth on the homing plate, wiper 19, back contact and armature 10, back contact and armature 14, interrupter springs 16, winding of rotary magnet DM to battery. The rotary magnet returns the wipers to the home position.

The release magnet circuit of the first code selector FCS is also completed from earth, armature 36 and back contact, armature 42, off-normal springs 70, release magnet Z to battery, thereby returning the shaft and wipers to normal.

Earth is extended from the homing plate of the register controller selector RCS, over wiper, conductor 80, armature 35, armature 63, conductor 81, interrupter springs 82, winding of rotary magnet DM1 to battery. The wipers of the register controller selector are thus returned to the home position.

It will be noticed that the guarding earth is not taken from wiper 18 until both relays B and BA have released. This ensures that succeeding switches in the train are released before the first code selector can again be seized.

If the called subscriber had been busy, busy flash and tone signals would be transmitted, to the calling subscriber and should the calling subscriber hang up during the battery period of the busy flash, a circuit is completed from earth, armature 68, back contact and armature 23, armature 27, winding of impedance relay I, make spring controlled by armature 31, armature 46 and front contact to battery, from the switch supplying the busy flash. This circuit holds the impedance relay I energized until battery period is replaced by the tone period. Impedance relay I in turn maintains guard relay B operated and when relay I releases relay B will also release the release of the switch taking place as described above. This feature keeps the first code selector guarded until the battery period of the busy flash is completed thereby preventing any possibility of unguarded intervals on the junction.

When the subscriber dials the first digit of the office code, the wipers of the A digit switch are raised to the required level where they will hunt to find an idle B and C digit switch. If all the B and C digit switches connected to the contacts on the level are busy, the wipers will rotate over the bank and on the 11th step operate the cam springs 290. An earth is then extended from cam springs 290, contact and wiper 268 of the register selector switch RS, armature 255, winding of pulse relay PD to battery. Pulse relay PD operates and extends earth from armature 265 over conductor 172, winding of busy relay BR, conductor 174, second bank contact and wiper 189 of the digit distributor switch DD (which steps off the first contact after the first series of pulses) conductor 166 to battery. Busy relay BR operates and connects busy tone over conductor 156 and armature 144 to conductor 85, whence it reaches the calling subscriber over bank contact and wiper of register controller selector RCS, conductor 77, armature 24, line condenser, bank contact and wiper 17 of subscriber's line switch, and armature 11 of the switching relay K to the calling subscriber.

A meter is connected to the 11th bank contact of the A digit switch and registers for traffic indications. The subscriber on hearing the busy tone should hang up his receiver, but if he fails to do so for some time the time pulse operates time pulse relay TP and then forced release relay M operates, releasing the register controller and sending number unobtainable tone to the calling subscriber. The operation of the time pulse is described under the delayed dialling paragraph. The change of tone from busy tone to N. U. tone indicates to the subscriber that the apparatus he was holding has released.

If the subscriber wishes to call an operator he dials "O". This raises the A digit switch ADS to the 10th level and closes the normal post springs 288 which are adjusted to make when the shaft reaches this level only. Relay O operates and connects wiper 291 to the lower winding of switching relay K3. Series relay C2 operates in series with the vertical magnet VM1 and closes the circuit for rotary relay E1 which locks energized. When series relay C2 releases the rotary magnet RM1 is energized and steps the wipers to the first set of contacts, at the same time breaking the circuit of rotary relay E1 which thereby releases.

This contact is wired to a code sending switch direct and if the code sending switch

is at normal earth is extended from wiper 324, bank contact, winding of relay S1 bank contact and wiper 291 of A digit switch, armature 273, armature 285 and front contact, armature 279, winding of switching relay K3 to battery. If the code sending switch were in use, this circuit is completed as soon as it reaches its normal position.

Switching relay K3 operates and locks energized from earth, armature 274 and front contact, armature 284 and front contact, front contact and armature 278, upper winding of relay K3, cam springs 290, interrupter springs off-normal springs 289, winding of rotary relay E1 to battery. Armature 278 is adjusted to make before armature 279 breaks, to ensure the completion of the locking circuit, while rotary relay E1 does not operate in series with switching relay K3. The code sending switch now steps round its bank, its operation being as previously described and will return pulses into the register controller as may be required to set up the code register switches, to route the call to an operator.

If we assume the routing digits required to reach an operator are 2468, the code register switch CR1 is operated twice, code register switch CR2 four times, CR3 six times, the relay K5 switches and code register switch CR4 is operated eight times.

The strapping on the code sending switch bank is arranged so that when no numerical digits are required, an extra pulse is transmitted to pulse relay PD. After sending the last digit i. e. eight, relay PD receives a pulse which causes start relay ST to operate, and then relay PD receives an extra pulse, which causes relay KO to operate from earth, armature 264, armature 243 and front contact, armature 246 and front contact, winding of relay KO to battery. Relay KO locks energized over its own armature 250, conductor 161, busy key 150, armature 135, busy key 150 to earth.

The A digit switch is released and the sender switch SS in the register controller starts rotating, impulses being sent out and the various switches being energized, as described previously.

The sender control switch SC steps between each series of impulses and when it reaches the fifth contact i. e. after the fourth digit has been sent, the earth over armature 249, conductor 233, wiper 186 and No. 5 bank contact is extended over wiper 199 and normal position bank contact of code register switch CR5, conductor 232, armature 251, conductor 181, make spring controlled by armature 103, winding of cut-off relay CO to battery. Cut-off-relay CO operates and releases the register controller in the manner previously explained, the magnets of the switches off normal being energized through the coil of the release relay RA to provide release alarm facilities should any of them fail to return to normal.

The subscriber is now connected through to an operator and when conversation with the operator is completed the release of the first code selector and other switches held in the train takes place as described before.

Should the subscriber operate his dial before receiving dial tone two possibilities may arise, for instance, the subscriber may dial before the register controller selector has found a register controller or he may dial before the register selector has found an A digit switch.

In the first case while the register controller selector is hunting for a register controller, impulsing relay A of the first code selector FCS is maintained energized in series with shunt field relay D and impedance relay I. When the subscriber dials, line relay L1 pulses in synchronism, and opens the circuit of relay A which in turn pulses. Shunt relay C has already operated and each time relay A releases a circuit is completed for vertical magnet VM as follows: earth, armature 34, armature 57 and back contact, armature 52 winding of vertical magnet VM to battery. The vertical magnet operates and steps the wipers up to the level corresponding to the number dialled, the off-normal springs closing with the first vertical step and completing a holding circuit for shunt relay C, and also an energizing circuit for rotary relay E.

With the first pulse to the vertical magnet a circuit is also completed for relay M in a branch of the above circuit, over armature 28, armature 62, lower winding of relay M to battery. Relay M operates and locks energized over armature 64 to earth over armature 36. The operation of relay M at this time prevents the operation of switching relay H, as its circuit is opened at armatures 59 and 60.

When shunt relay C restores after the series of impulses have been transmitted the rotary magnet is energized in the circuit extending from earth, armature 33, make spring controlled by armature 48, armature 55, rotary magnet RM to battery. The rotary magnet operates, steps the wipers on to the first set of contacts and breaks the circuit of rotary relay E. When the rotary magnet restores relay E again energizes in the circuit extending from earth, armature 36 and front contact, armature 39 and back contact, front contact and armature 60, cam springs 71, rotary interrupter springs 53, off-normal springs 70, winding of relay E to battery.

The rotary magnet circuit is again completed and it operates, steps the wipers and breaks the circuit of rotary relay E.

This sequence of operations is completed till the eleventh step is reached when the cam springs 71 are operated and relay E cannot again operate. Number unobtainable tone is now given to the calling subscriber from

conductor 226 over armature 66, cam springs 71, tone condenser, line condenser, bank contact and wiper 17, armature 11 to calling subscriber, who on hearing the tone will replace his receiver, thereby releasing the switches. The supervisory lamp is lit in the first code selector, and if the subscriber delays replacing his receiver, an alarm operates and the lamp indicates which first code selector is held.

In the second case when the register selector is hunting for an A digit switch, the circuit of relay A in first code selector is maintained by the battery over resistance connected to resting springs 248 of start relay ST in the register controller.

When the subscriber dials relay L1 impulses and opens the circuit of relay A1 in the register controller which in turn impulses, completing the following circuit: earth, busy key 150, armature 101 and front contact, armature 108, armature 129 and back contact, armature 132, armature 143, conductor 171, wiper 190, and first bank contact of digit distributor switch DD, conductor 179, lower winding of forced release relay M1, conductor 176, conductor 218, back contact and armature 252, conductor 215, first bank contact and wiper 189 of the digit distributor switch DD, conductor 166 to battery.

Relay M1 operates, locks energized and breaks the circuit of relay A in the first code selector, and at the same time connects battery to conductor 84, thereby allowing relay M in first code selector to operate over its low resistance winding.

The releasing of relay A in the first code selector completes a circuit for energizing the vertical magnet, and the operation of relay M in the first code selector opens the circuit of impulsing relay A1 of the register controller which in turn releases guard relay B1. When guard relay B1 has fully restored, the holding earth is removed from conductor 86, allowing relay K1 in the first code selector to release and complete the circuit for relay A, which re-energizes.

The releasing of guard relay B1 frees the register controller leaving it available for use on other calls.

The shaft and wipers of the first code selector have been raised one step, and will cut in on the first level. As relay M is operated they will rotate to the eleventh step, switch the cam springs and N. U. tone will be given to the calling subscriber, as described in the first case.

The calling subscriber on hearing the tone will replace his receiver, thereby releasing the switches, and attempt to set up the call at some later time.

If the subscriber delays dialling, or delays successively between digits the circuit is so arranged that the register controller is released (as well as the A digit switch and B and C digit switch if they are still held) leaving it available for other calls, while N. U. tone is given to the calling subscriber.

As soon as guard relay B in the register controller is operated the time pulse lead 158 is extended over springs of time pulse disconnecting key 150, back contact and armature 96, armature 92 and back contact, armature 142, armature 104, armature 134, lower winding of time pulse relay TP to battery. Time pulse relay TP is a two-step relay and first operates its armature 93, operating fully when the time pulse ceases and locking energized in the following path: earth, busy key 150, armature 135, busy key 150, armature 93, upper winding of two-step relay TP, armatures 142, 104 and 134, lower winding of relay TP to battery.

If the subscriber dials now, shunt relay C operates and breaks down the time pulse relay, allowing the circuit operations to proceed, but assuming that he still delays the next time pulse (occurring at stated intervals of time) operates forced release relay M1 from time pulse earth, busy key 150, armature 96, armature 92 and front contact, winding of relay M1 to battery. Relay M1 locks energized over its own armature 159'.

The operation of forced release relay M1 breaks the circuit of relay A in the first code selector which releases and at the same time connects battery to conductor 84, allowing forced release relay M of the first code selector to operate on its low resistance winding.

The operation of relay M in the first code selector opens the circuit of impulsing relay A1 in the register controller which in turn opens the circuit of guard relay B1. The releasing of guard relay B1 removes the holding and guarding earth from the register controller leaving it available for further service.

Switching relay K1 of the first code selector releases and impulse relay A re-energizes. The momentary release of impulse relay A energizes the vertical magnet VM1 which raises the wipers one step. The wipers will now cut in on the first level and rotate to the eleventh bank contact where the cam springs are switched and N. U. tone is given to the calling subscriber.

The calling subscriber will replace his receiver thereby releasing the switches.

When the subscriber makes a call which does not involve any numerical digits, such as call to Enquiry, Information or similar calls, the register controller is arranged to release immediately after sending the required translated code digits. This is accomplished by arranging the strapping on the bank of the code sending switch CSS so that pulse relay PD receives an extra pulse i. e. three in all. Normally on a call which has numerical digits pulse relay PD receives two pulses,

one to operate the switch relay K5 after the first three code register switches have been set up and the second one to operate the start relay ST, but on a call which may be cut off immediately after the sending of the translated code digits, a third pulse is given to pulse relay PD. This causes relay KO to operate and lock over its own armature 250.

The register controller begins to send the necessary routing digits, the sender control switch stepping between each series of impulses and assuming three digits are required to route the call, when the sender control switch steps to the 4th position, the earth is extended from armature 249, over conductor 233, wiper 186 and No. 4 bank contact of the sender control switch, wiper 198 and normal position contact of code register switch CR4, conductor 232, armature 251 and back contact, conductor 181, make spring controlled by armature 103, winding of cut off relay CO to battery. The operation of cut off relay CO returns the sender switch SS and sender control switch SC to their home positions, at the same time completing the releasing circuit for the code register switches.

It also opens the circuit of guard relay B1 which releases removing the holding and guarding earth from the register controller leaving it free for further service.

The operations in the first code selector are as previously described, and the subscriber is now connected through as desired.

If an accidental impulse is given when the subscriber is switched through to the A digit switch ADS (or if the subscriber dials "one") the circuit of the A digit switch ADS is arranged so that the wipers return to normal and the correct number can be dialled without risk of mutilation.

If the A digit switch receives one impulse only, the normal post springs 225, which are adjusted to make on this level only, are operated, opening the rotary magnet circuit and completing the release magnet circuit as follows: earth, armature 274 and front contact, break spring controlled by armature 272, normal post springs 225, off-normal springs 289, release magnet Z1 to battery.

The wipers are thereby returned to normal and the subscriber can then dial his correct code.

If the subscriber dials any office designation which is not in service, he receives an N. U. tone indicating he has dialled a wrong office designation.

All contacts associated with wiper 313 of the B and C digit switch BCS which are not in use are connected to earth.

When the B and C digit switch wipers rest on contacts which are not in use, earth is extended over wiper 313 front contact and armature 311, armature 303, bank contact and wiper 292 of A digit switch ADS, armature 283, front contact and armature 275, bank contact and wiper 266 of register selector RS, armature 253, conductor 231, conductor 179, lower winding of forced release relay M1, conductor 176, third bank contact and wiper 189 of the digit distributor switch DD, conductor 166 to battery.

Forced release relay M1 operates and operates forced release relay M in the first code selector. The remaining operations are as previously described, N. U. tone being given to the calling subscriber over conductor 226.

An alarm is arranged to be given by the register controller if either the magnet pulse springs 89 or the loop pulse springs 124 are not functioning correctly.

If the alarm condition arises the register controller is freed from the call, N. U. tone being given to the calling subscriber who will make another call. The register controller on which the fault has arisen is busied to prevent it being used till the fault is cleared and the circuit manually released by throwing the busy key 150. The lamp on the register controller flickers indicating on which circuit the fault has arisen.

If either the loop pulse springs 124 or the magnet pulse springs are not functioning correctly, control relay CC will not operate, its operation depending on the correct working of pulse springs 89 and also upon operation of loop closing relay LC, which in turn depends on the correct working of pulsing springs 124. If control relay CC does not operate, when the digit distributor switch wiper 189 reaches the second contacts a circuit is completed for pulse alarm relay PA from earth, busy key 150, winding of pulse alarm relay PA, break spring controlled by armature 98, armature 122, conductor 174, bank contact and wiper 189 of digit distributor switch, conductor 166 to battery. Pulse alarm relay PA operates and locks itself to earth on busy key 150 over its own armature 98. The operation of relay PA connects intermittent earth from conductor 152 over armature 95 to the lamp to indicate on which circuit the fault has arisen, and also connects the intermittent earth over armature 96 to the time pulse relay TP, which first operates armature 93, afterwards operating fully, and transferring the intermittent earth to the winding of forced release relay M1. Forced release relay M1 operates and operates forced release relay M of the code selector FCS which in turn breaks the circuit of impulse relay A1, of the register controller, releasing guard relay B1.

The operations in the first code selector are similar to those already described.

The operation of pulse relay PA also operates relay DS from earth, busy key 150, armature 135, busy key 150, armature 94 and front contact, winding of relay DS to battery. The releasing of guard relay B1 removes

earth from conductor 86, allowing switching relay K1 of the first code selector to restore, and at the same time opens the circuit for relay DS which is slow to release. When relay DS has released the conductor 86 is again connected to earth, over armature 112, armatures 99 and 102 to conductor 86. This arrangement provides a short period during which the earth is removed from holding conductor 86, allowing other relays held on this conductor to release, the conductor being immediately afterwards reguarded.

This prevents the register controller from being seized for another call till relay PA is released, which can only be done by throwing the busy key 150.

An alarm circuit is completed by the operation of pulse alarm relay PA, and the flickering of the lamp indicates on which register controller the fault has occurred.

If for any reason it is found impossible to transmit impulses from the register controller, due to say, a switch in the train having most of its outlets busy, then current to the register controller is reversed over the switch.

This allows shunt field relay D1 to operate and hold stop relay SZ in a circuit extending from: earth, bank contact and wiper 184 of switch SC, lead 164, front contact and armature 88 of relay D1, armature 128 and front contact, winding of relay SZ to battery, (relay SZ operated at the conclusion of the last series of impulses) thus maintaining the loop across the loop pulsing springs 124.

When the switch ahead is prepared to receive impulses the direction of battery is again reversed and shunt field relay D restores, allowing stop relay SZ to restore and the register controller to proceed with its sending.

If all the outlets from the first code selector level are busy, on the eleventh step the cam springs 71 are operated and busy tone is connected over conductor 227, armature 66, cam springs 71, tone condenser, line condenser bank contact and wiper 17 of line switch, armature 11 of switching relay K to calling subscriber.

The calling subscriber hearing the busy tone will replace his receiver, and release the equipment, but if he does not immediately do so, the register controller will continue to send out impulses, which as switching relay H has not operated, are received by impulse relay A. Relay A will pulse but no circuit is affected and at the conclusion of sending pulses the register controller automatically releases itself in the standard manner.

I claim:—

1. In a register sender for use in a telephone system, a plurality of impulse-operated registers, means directly controlled over a calling telephone line for setting one group of said registers, means indirectly controlled over the calling line for setting the remaining ones of said registers, and sending apparatus successively controlled by all of said registers to transmit a series of impulses under the control of each register in turn, the number of impulses in each series transmitted by said sending apparatus bearing a fixed numerical relation to the number of setting impulses received by the corresponding register.

2. In a register sender for use in a telephone system, a plurality of impulse-operated registers, means directly controlled over a calling telephone line for setting one group of said registers, means indirectly controlled over the calling line for setting the remaining ones of said registers, and sending apparatus successively controlled by all of said registers to transmit a series of impulses under the control of each register in turn, the number of impulses in each series transmitted by said sending apparatus being the same as the number of setting impulses received by the corresponding register.

3. In a register sender for use in a telephone system, a plurality of impulse operated registers, means directly controlled over a calling telephone line for setting one group of said registers, means indirectly controlled over the calling line for setting the remaining ones of said registers, and sending apparatus successively controlled by all of said registers to transmit a series of impulses under the control of each register in turn, the number of impulses in each series transmitted by said sending apparatus under the control of the indirectly controlled registers bearing a fixed numerical relation to the number of setting impulses received by the corresponding register.

4. In a register sender for use in a telephone system, a plurality of impulse-operated registers, means directly controlled over a calling telephone line for setting one group of said registers, means indirectly controlled over the calling line for setting the remaining ones of said registers, and sending apparatus successively controlled by all of said registers to transmit a series of impulses under the control of each register in turn, the number of impulses in each series transmitted by said sending apparatus under the control of the indirectly controlled registers being the same as the number of setting impulses received by the corresponding register.

5. In a telephone system, a register sender, two groups of progressively movable registers therein, means for extending a connection from a calling line to said register sender, control apparatus common to said register sender and to a plurality of others, means subsequently controlled over the calling line for extending a connection from said register sender to said common control apparatus, said common control apparatus being effective to set one group of said registers in said

register sender, means controlled over the calling line for setting the other group of said registers independent of said common control apparatus, and an impulse sender arranged to operate successively under the control of all said registers.

6. In a telephone system comprising a plurality of separate offices or exchanges, register controllers in one exchange, a separate impulse sending device for each of said exchanges, said impulse sending devices being common to a plurality of said register controllers, and numerical switching apparatus common to a plurality of said register controllers and arranged to set up a connection from any register controller to a desired one of said impulse sending devices responsive to a portion of a telephone number indicating the exchange to which the last-named impulse sending device is individual.

7. In a telephone system including a plurality of offices or exchanges, register controllers in one exchange arranged to be set in accordance with the complete number of a desired subscriber, a portion of such number being used to identify the called exchange, there being a separate code assigned to each exchange, apparatus common to a plurality of register controllers and arranged to translate from the exchange-indicating portion of a telephone number to the corresponding exchange code, and means for sending trains of impulses from said common apparatus to any one of the register controllers to which it is common corresponding exactly to a complete translated exchange code.

8. In a telephone system including a plurality of offices or exchanges and employing register controllers in one exchange arranged to be set in accordance with the number of a wanted party, step-by-step progressively movable registers in each register controller, controlling apparatus common to a plurality of register controllers, means for temporarily associating said controlling apparatus with any desired one of said register controllers by means of a plurality of conductors, and means controlled from said controlling apparatus for simultaneously operating a plurality of said step-by-step registers, each register being operated over a separate conductor.

9. In a telephone system wherein combinations of digits are translated into preassigned different combinations of digits, a plurality of register controllers, translating apparatus common to a plurality of said register controllers, means for taking a register controller for use; for recording the digits to be translated; for connecting the register controller with the common apparatus; for transferring the translated digits back to said register controller, and a plurality of step-by-step switches in said register controller arranged to record the said translated digits.

10. In a telephone system wherein combinations of digits are translated into preassigned different combinations of digits, a plurality of register controllers, translating apparatus common to a plurality of said register controllers, means for taking a register controller for use; for recording the digits to be translated; for connecting the register controller with the common apparatus; for transferring the translated digits back to said register controller, a plurality of said translated digits being transferred back at the same time, sending apparatus in said register controller arranged to transmit a plurality of series of impulses corresponding, respectively, to the translated digits, and a train of automatic switches responsive to the series of impulses.

11. In a telephone system as claimed in claim 7, means for causing the trains of impulses to be sent from the common apparatus in stages, a plurality of trains of impulses being sent simultaneously during each stage.

12. In a telephone system as claimed in claim 6, means for operating an impulse sending device individual to an exchange only when a connection is to be set up to the exchange to which such device is individual.

13. In a multi-exchange telephone system wherein register senders are controlled over calling lines in accordance with wanted telephone numbers and in turn control the setting up of connections to wanted lines through automatic switching apparatus, a group of register senders in one of said exchanges, a group of sending devices associated with said register senders including a separate sending device for each of said exchanges, each of said sending devices being common to all of the register senders in said group, a train of automatic switches arranged to set up connections from the register senders to said sending devices, each of said register senders having a non-numerical switch individual thereto, means for taking any one of said register senders for use and for operating the non-numerical switch individual thereto to extend a connection to the first switch in the said train, means responsive to the digits indicative of the called exchange for operating said train of switches to extend a connection from the register sender to the sending device individual to the desired exchange, means in the register sender for registering the digits indicative of the desired line in the called exchange, means in the sending device for transmitting back to the register sender the digits necessary to trunk the call to the desired exchange, registering apparatus in the register sender for registering such digits, and sending means in said register sender for sending out to the automatic switches the last-mentioned digits registered

in the register sender and for sending to the automatic switches the digits registered in the register sender indicative of the called line.

14. In a multi-exchange telephone system wherein register senders are controlled over calling lines in accordance with wanted telephone numbers and in turn control the setting up of connections to wanted lines through automatic switching apparatus, a group of register senders in one of said exchanges, a group of sending devices associated with said register senders including a separate sending device for each of the said exchanges, each of said sending devices being common to all of the register senders in said group, a train of automatic switches arranged to set up connections from the register senders to said sending devices, each of said register senders having a non-numerical switch individual thereto, means for taking any one of said register senders for use and for operating the non-numerical switch individual thereto to extend a connection to the first switch in the said train, means responsive to the digits indicative of the called exchange for operating said train of switches to extend a connection from the register sender to the sending device individual to the desired exchange, means in the sending device for transmitting back to the register sender the digits necessary to trunk the call to the desired exchange, registering apparatus in the register sender for registering such digits and sending means in the register sender for sending the translated digits to the automatic switches under the control of said registering apparatus.

15. In an automatic multi-exchange telephone system, a group of register senders, a non-numerical trunking switch individual to each register sender, numerical trunk switches accessible to said non-numerical switches, a separate sending device for each exchange in the system, means controlled over a calling line for operating the non-numerical switch individual to a register sender and for operating a train of said numerical switches to extend a connection to the sending device assigned to a desired exchange, digit registering devices in the said register sender, and means for operating the selected sending device to transmit digits back through the train of numerical trunking switches to set the said digit-registering devices in said register sender.

16. In a multi-exchange automatic telephone system, register senders, means controlled over a calling subscriber's line for taking a register sender for use, digit-sending apparatus, means including automatic switches common to all said register senders and responsive to the exchange digits dialled by the calling subscriber for extending a connection from said register sender to said digit-sending apparatus, means for operating the digit-sending apparatus to transmit to the register sender the digits necessary to trunk the call to the desired exchange, registering apparatus in said register sender for registering the said digits, and sending apparatus operable under the control of the registering apparatus to send the registered digits to the automatic switches for the purpose set forth.

17. In a multi-exchange telephone system employing register senders, a group of register senders in one exchange, a group of digit sending devices in said exchange comprising a separate digit-sending device for each exchange, and means for extending a connection from any register sender to any one of said digit-sending devices, said last means including a non-numerical switch individual to the register sender and two directively-controlled, serially-related switches common to all of said register senders.

18. In a register sender for use in a telephone system, a plurality of impulse-operated registers, means indirectly controlled over a calling telephone line and including number-translating apparatus for setting one group of said registers, means directly controlled over the calling line for setting the remaining ones of said registers, and sending apparatus successively controlled by all of said registers to transmit a series of impulses under the control of each register in turn, the number of impulses in each series transmitted by said sending apparatus under the control of the indirectly-controlled registers bearing a fixed numerical relation to the number of setting impulses received by the corresponding register.

In testimony whereof I have signed at Liverpool, England, this 24th day of Aug., 1928.

JOHN ELLIS OSTLINE.