

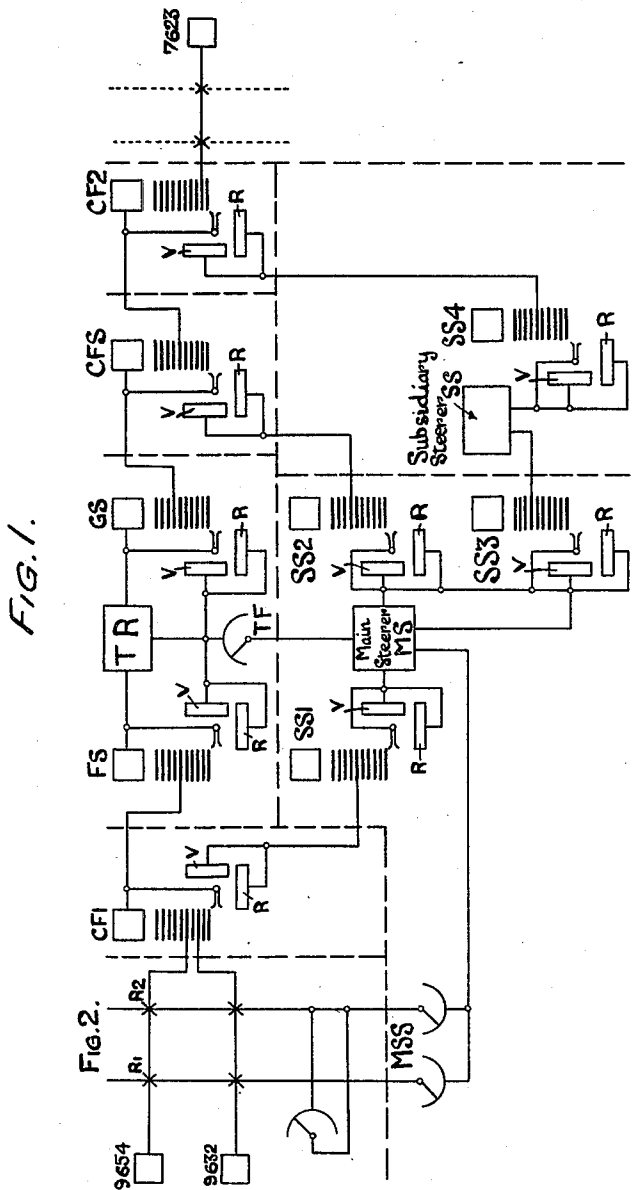
May 28, 1929.

R. MERCER
TELEPHONE SYSTEM

1,714,718

Filed Oct. 31, 1924

6 Sheets-Sheet 1



INVENTOR-RICHARD MERCER.
Char. W. Condy. ATTY.

May 28, 1929.

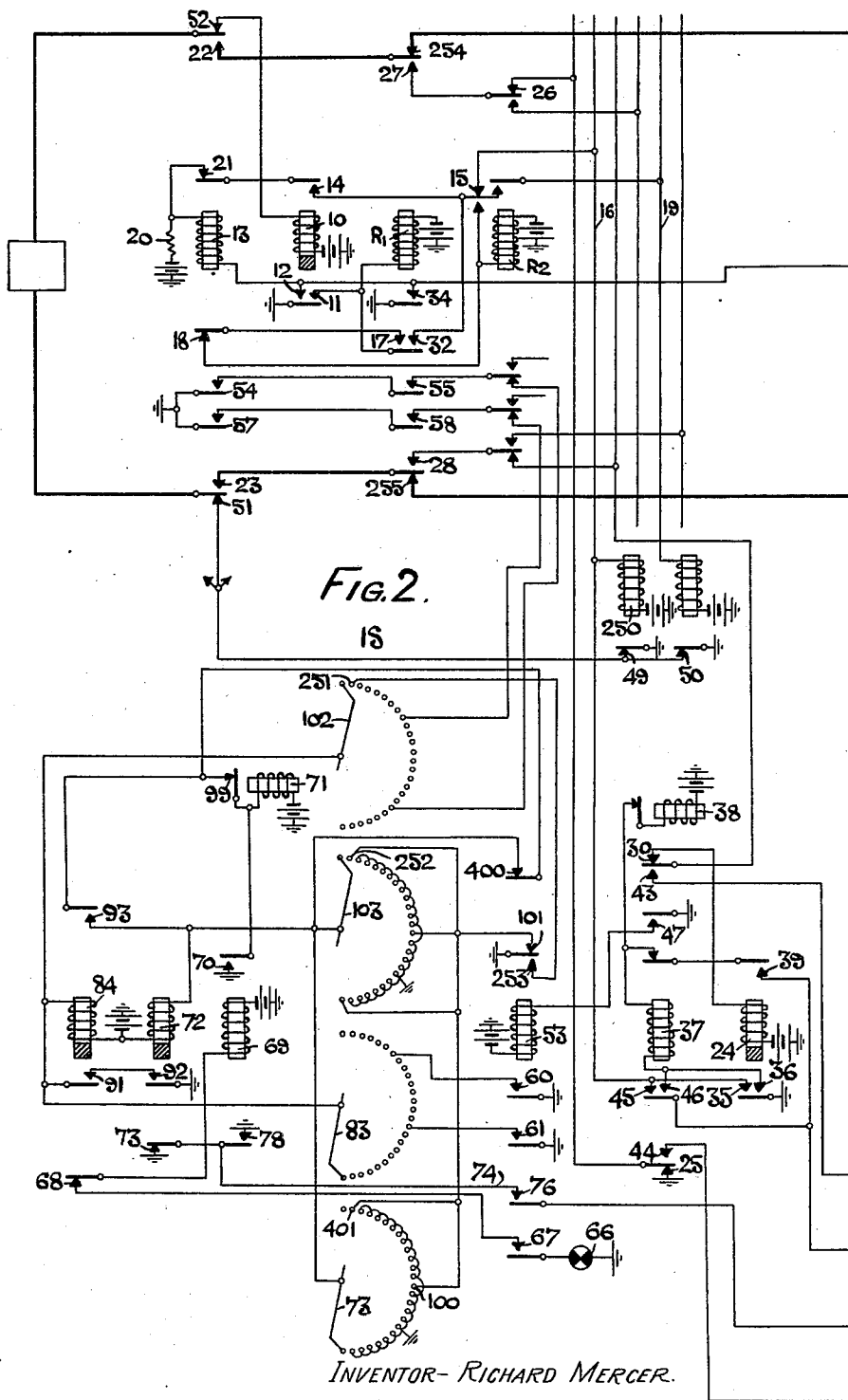
R. MERCER

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TELEPHONE SYSTEM

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6 Sheets-Sheet 2



INVENTOR- RICHARD MERCER.
Chas. W. Candy, ATT. Y.

May 28, 1929.

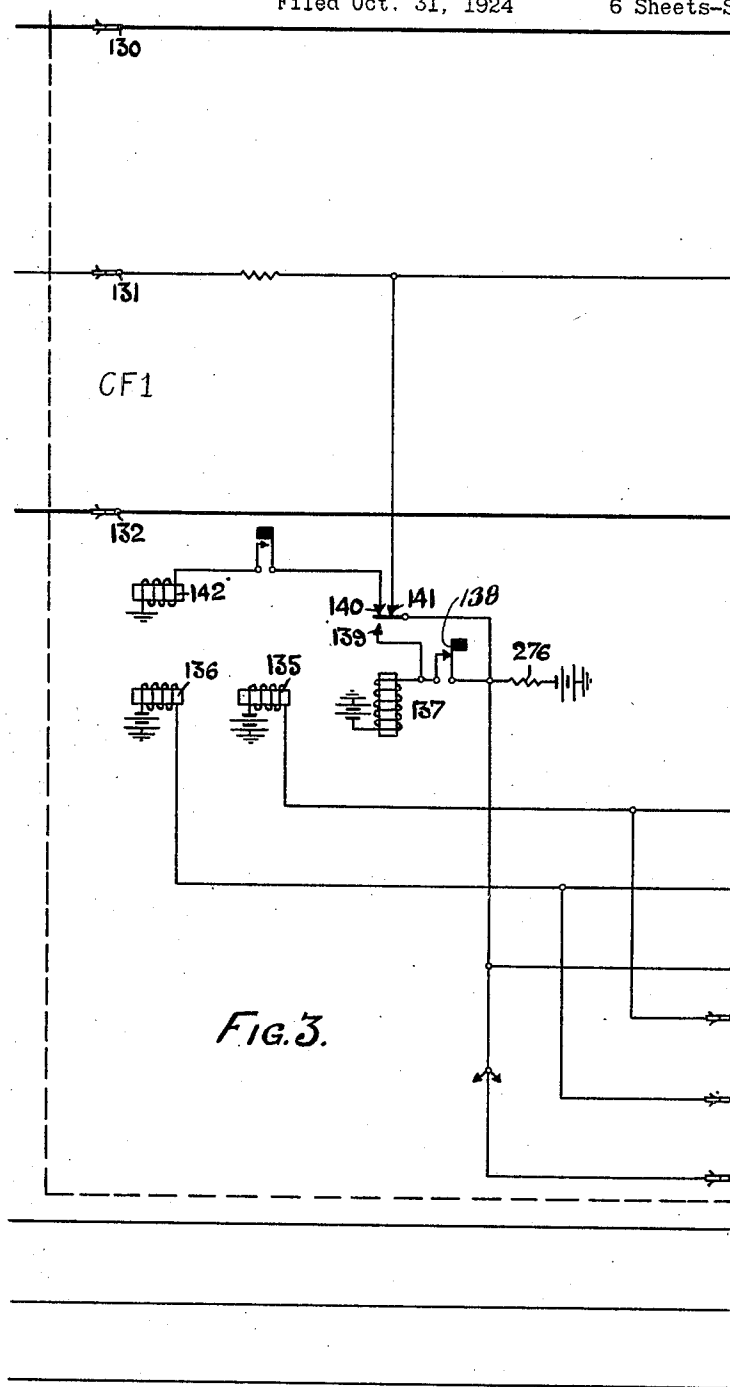
R. MERCER

1,714,718

TELEPHONE SYSTEM

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6 Sheets-Sheet 3



INVENTOR-RICHARD MERCER
Chas. H. Condy, ATTY.

May 28, 1929.

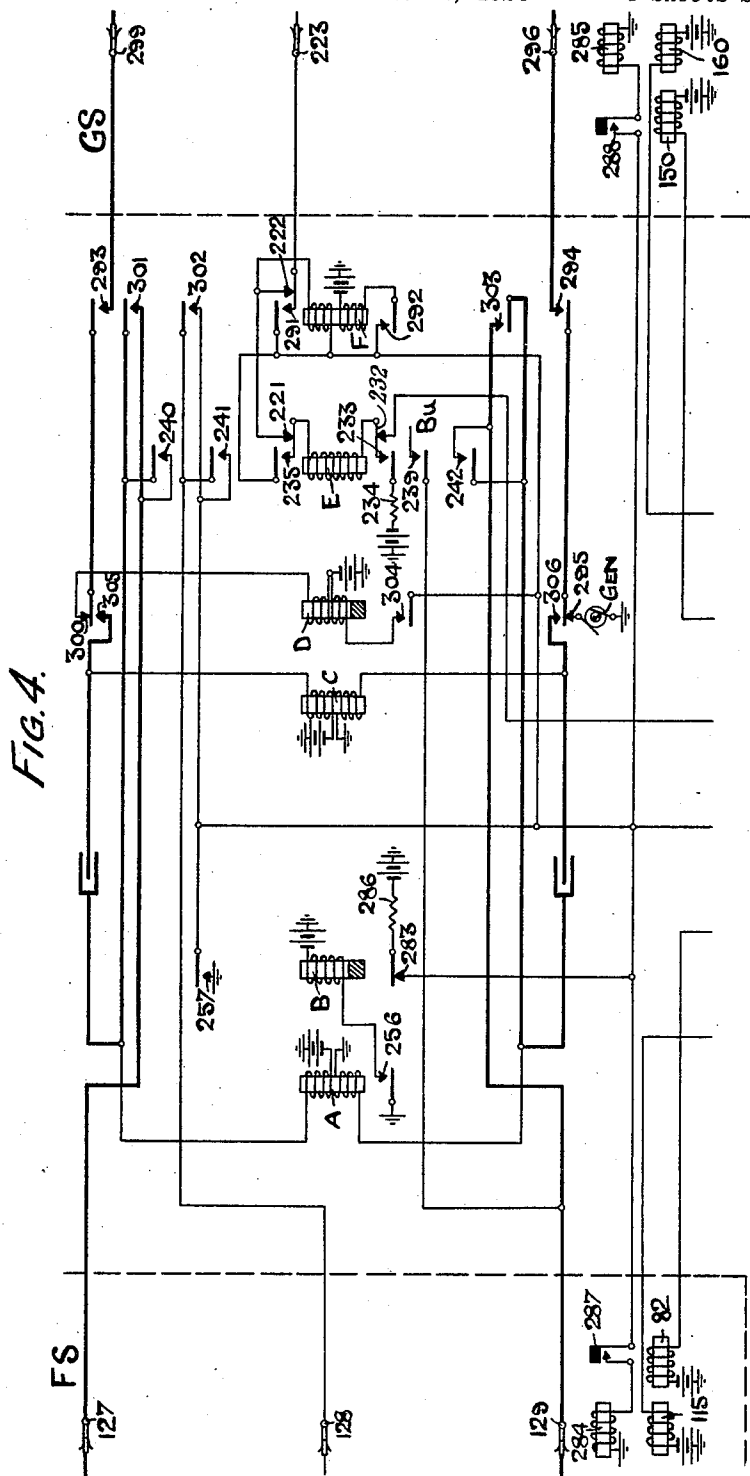
R. MERCER

1,714,718

TELEPHONE SYSTEM

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6 Sheets-Sheet 4



INVENTOR- RICHARD MERCER
Chas. H. Candy. ATTY.

May 28, 1929.

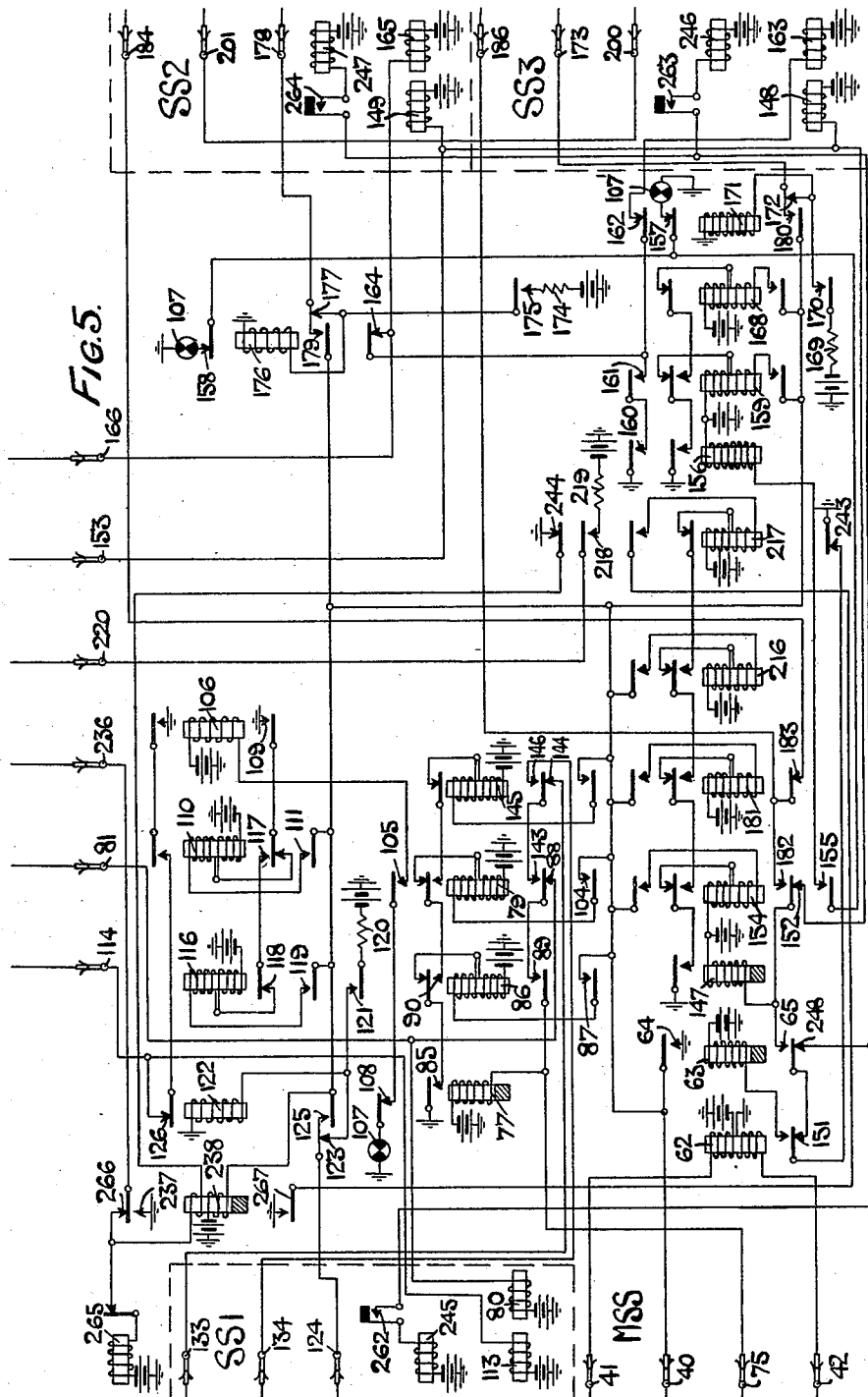
R. MERCER

1,714,718

TELEPHONE SYSTEM

Filed Oct. 31, 1924

6 Sheets-Sheet 5



INVENTOR- RICHARD MERCER

Chas. T. Condy. ATTY.

May 28, 1929.

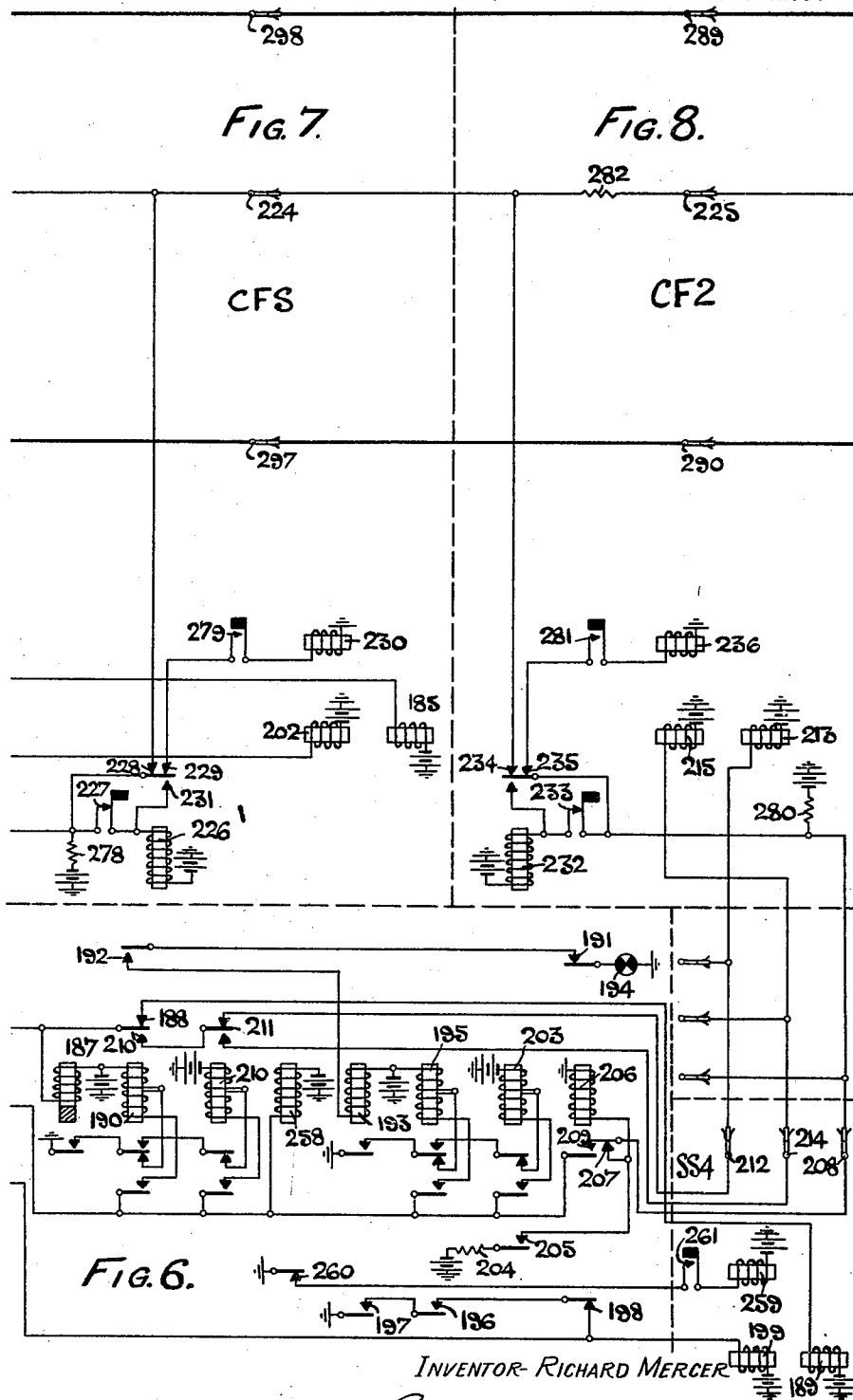
R. MERCER

1,714,718

TELEPHONE SYSTEM

Filed Oct. 31, 1924

6 Sheets-Sheet 6



UNITED STATES PATENT OFFICE.

RICHARD MERCER, OF HARROW, ENGLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO
AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELA-
WARE.

TELEPHONE SYSTEM.

Application filed October 31, 1924, Serial No. 746,992, and in Great Britain November 6, 1923.

The present invention relates to improve-
ments in or relating to automatic telephone
systems and more particularly concerns the
general lay-out of the apparatus used in con-
5 connection with such systems. For some time it
has been realized that certain controlling ap-
paratus of an expensive nature could only
be afforded to be linked up to a connection
temporarily so that the apparatus would be
10 provided in a small quantity less in quantity
than the number of apparatus simultaneous-
ly in use with which apparatus they are
adapted to be associated. This particularly
applies to registers or registering translat-
15 ing devices, but it also applies to the case
where special facilities require to be pro-
vided, such as zone metering and inter-office
trunking; other arrangements have probably
also been contemplated but have not become
20 possible because of the fact that the cost of
the apparatus, finder switches or the like
which temporarily associates the apparatus
with the switches used in setting up a connec-
tion more than compensates for the saving
25 effected. At the same time it has been usual
to control the operation of switches over the
line and test conductors and over the line
and test wipers of the switches successively
taken into use in the setting up of a connec-
30 tion, thereby necessitating the provision of a
number of relays, sequence switches, side
switches or the like permanently associated
with the switch for the purpose of effecting
the control of the various operating magnets,
35 clutch magnets or the like. Broadly speak-
ing the principal feature of the present in-
vention consists in the elimination of all
such permanently associated controlling ap-
paratus which is only essential for the set-
40 ting up of the connection. By these means
not only can the cost of the temporarily as-
sociated apparatus be compensated, but ac-
tually a saving may be effected in the actual
cost of apparatus used in an exchange while
45 further additional facilities could be readily
added at a comparatively small expense.
While the invention is applicable to the var-
ious types of switches used in connection
with automatic telephony, for instance power
50 driven switches or step by step switches and
in certain cases to relay switches, it will be
described in connection with a well known
system employing two directional switches

of the step by step type. As is well known in
such systems, a number of relays are asso-
55 ciated with each two-directional switch,
which relays although connected in perma-
nent association therewith, are only used ac-
tually during the transmission of impulses,
so that their useful life is very small indeed. 60
Such relays naturally have a life far exceed-
ing the life of the switch with which they
are associated, and therefore are, compara-
tively speaking, expensive for their use, and
as the cost of a relay is a small but important 65
percentage of the cost of the switch itself, it
will be appreciated that the cost of each
switch is unduly increased by having such
relays permanently connected to them.

The invention in addition to the produc- 70
tion of a more economical system also effects
the simplification of the switches so that the
switch becomes a mechanical construction al-
most entirely and can be used for different
purposes or in different relative positions in 75
the setting up of a connection without any
alteration in its circuit or constructional de-
tails. One advantage of this arrangement
is that the maintenance of the switches is al-
most entirely mechanical and not a combina- 80
tion of a relay maintenance with mechanism
maintenance which has hitherto been essen-
tial. Again, by providing for the controlling
relays to be common to a plurality of
switches, other auxiliary apparatus for spe- 85
cial purposes, such as zone metering, inter-
exchange routing or satellite working may
be provided very economically.

Another object of the invention is the 90
modification of the switching layout and the
use of switches for two or more purposes
which becomes readily possible when the op-
eration of the switches is controlled from an
auxiliary path.

One of the features of the present inven- 95
tion is the provision in addition to the
switches used throughout a connection of an
auxiliary set of switches or steering appar-
atus taken into use only during the setting up
of a connection and adapted to control the 100
operation of the switches in the speaking
route individually, for instance, when em-
ploying switches of the step by step type
having movement in two directions, the mag- 105
nets are controlled over circuits leading di-
rect from the steering apparatus which may

be over the wipers of an auxiliary switch and are independent of the talking or other conductors leading from the preceding switch in the speaking route. The steering apparatus may conveniently include switches corresponding to the switches in the speaking route and adapted to move with the switches in the speaking route and control their operation so that when the switch in the speaking route establishes connection to the talking conductors of an idle line the switch in the setting route establishes connection to the controlling or operating magnets of the same switch. The steering apparatus in addition includes switching means by which the operating impulses may be transmitted over different paths to or from the different controlling magnets.

In the large system it may be desirable to provide additional steerer devices in addition to those adapted to be first taken into use, so that the control of the switches in establishing a connection may be controlled partly through one steering device and partly through another.

Another feature of the present invention which becomes possible by employing the foregoing is a switch in which the wipers are connected permanently to the incoming leads. Such a switch may be used for different purposes such as talking, testing, trunk offering or the like, or again it may be used both as a connector and as a finder switch, depending upon the route over which it is taken into use, no alteration however being necessary in the switch itself. The operating magnets are controlled over a means of access separate from the talking conductors including the wipers of an auxiliary switch temporarily associated therewith; this applies not only to the impulse controlled magnets in a group selector or connector switch, but applies also to the hunting magnets of a group selector. In order to enable a wanted subscriber's line to be tested while keeping the switches guarded from outside interference, two separate test leads are provided which are disconnected during the setting of the switch until the test has been made.

A further feature of the invention which also arises out of the foregoing is a novel arrangement for connecting the calling subscriber to the first numerical switch. For maximum economy it is desirable that the steering apparatus should serve as large a group of subscribers as possible in order that the number of such apparatus should be small and further that the number to each group should be sufficiently great so as to ensure satisfactory working if one should be out of action for any reason. To attain this result it is desirable to arrange that the calling subscriber should be connected up in a similar manner and by similar switches as the called subscriber is connected up, from a central

trunk relay group including the battery feed relays, and in view of the simplicity of the switches and the fact that the switches may be used equally for connecting with a calling as well as a called line, this may be readily effected by means of the present invention. To obtain an alternative route which must be independent of any of the switches used in the talking route, two courses might be adopted, one to use a finder switch preferably of small capacity to find the calling line and arrange for the simultaneous operation of a hunting switch linked to the finder switch to find an idle steerer, or a small relay pre-selector in conjunction with a secondary line switch may be used; the relative advantages of the two arrangements depend upon the traffic conditions. In either case an impulse sender is controlled in such a manner as to send impulses corresponding to the number of the calling party to control the switches which establish connection to the calling line in the same manner as the switches which establish connection to the called line. The steerer is arranged to preselect an idle trunk relay group, while the connection to the calling line, as well as to the called, line is over switches in serial relationship. With switches having a capacity of 100 lines the steerers are therefore provided common to a group of 1000 lines. It may however be necessary to provide two or three groups of steerers per 1000 lines if the traffic conditions appear to warrant this; in which case all the switches in the exchange would be divided into similar groups. Means for arranging that the steerers or impulse senders have access to gradually increasing groups of lines can be provided, as will be readily understood by those versed in the art. While the invention can be readily applied to any size system, for the sake of simplicity a description will only be given of a 10000 line exchange of the simplest type, from which the above and other features of the invention will be understood.

The invention will be better understood by referring to the accompanying drawings which illustrate one manner of carrying the invention into effect applied to a 10,000 line exchange, without providing facilities for P. B. X. line selection.

Figure 1 gives a general layout of the novel system while Figures 2-8 give detailed circuit diagrams of the line circuit, connector finder circuit, trunk relays with finder and group selector switches, main steerer, subsidiary steerer, connector finder selector and a second connector finder circuit respectively, which when placed in positions corresponding to the arrangement of Figure 1, enable the operation of setting up a call from one subscriber to another to be followed.

Referring to Figure 1 a brief description describing the general outline of the sys-

tem will be given. The trunk relays TR are provided in groups to deal with the traffic of 1000 subscribers' lines and comprise battery feed, holding, switching, busy back and ringing relays and are the only relays which are provided adapted to be maintained in use throughout a connection with the exception of the relays individual to a line.

The trunk relays TR are connected directly to both a finder FS and a first selector GS, both of which are two directional step by step switches. The finder selector has access to ten groups of combination connector finders such as CF1 which are also two directional step by step switches and are adapted to be operated to establish connection with both a calling and a called line. The first selectors have access to second selectors such as CFS which in turn have access to connector finders such as CF1 or CF2. All the switches CFS, CF1 and CF2 are two directional switches having no interruption in the connection of their incoming and outgoing wiper connections. In addition there is a group of main steerers for each group of trunk relays and a group of subsidiary steerers for each group of second selectors. The main steerers are selected by main steerer selectors MSS individual to two outlets selected by relays R1, R2 individual to a subscriber's line; main steerers MS comprise a group of relays, three steerer switches SS1, SS2, SS3 all of which are of the two directional type and a trunk finder TF. SS1 controls the rotary movement of FS and connects up the magnets of CF1; SS2 controls the rotary movement of GS and connects up the magnets of CFS. SS3 connects up a subsidiary steerer SS which includes a group of relays and a steer switch SS4. The steer switch SS controls the rotary movement of CFS and connects up the magnets of CF2. In brief the operation is as follows:

Assuming subscriber No. 9654 wishes to call subscriber No. 7623, he lifts his receiver and relay R1 operates and if the first outlet is busy R2 also operates and selects the main steerer selector MSS which rotates to find an idle main steerer MS which is arranged to be in engagement with an idle group of trunk relays TR, over the finder switch TF.

Impulse transmission then begins. Relays R1 and R2 control the operation of an impulse sender to send out the last three digits of the calling subscriber's number, namely 654, while, possibly at the same time, the subscriber operates his impulse sender to send out the number 7623. Taking the first mentioned operation the first six impulses are arranged to control the operation of the vertical magnets of FS and SS1 so that both these switches are stepped up to the sixth level. Then the rotary movement of both switches is controlled in synchronism but

only the switch SS1 actually tests as both switches are arranged to have access to the same group of connector finders CF so that the magnets connected up by SS1 are those belonging to the same switch CF1 whose wipers are connected up by FS. The next two series of impulses pass over the wipers of SS1 and cause the wipers of CF1 to step up to the fourth contact of the fifth level to which the calling party's line is connected.

Meanwhile the impulses generated by the calling party cause the switches GS, SS2 and SS3 to step up to the seventh level. The rotary magnets of GS and SS2 are operated in synchronism until SS2 finds an idle second selector switch CFS so that GS establishes connection to the wipers at the same time as SS2 connects up the magnets of CFS. SS3 hunts in the usual way to find an idle subsidiary steerer SS. The next series of impulses (6) causes CFS and SS4 to step to the sixth level when both rotate in synchronism until SS4 finds an idle connector CF2 so that CFS connects up the wipers of CF2 while SS4 connects up its magnets. The next two series of impulses (23) step the connector CF2 up to the third contact of the second level to which the wanted subscriber's line is connected.

Momentarily, while the switches SS2 and SS4 guard the connection thus set up from intrusion, the wanted line is tested and either the busy relay is energized or the wiper relay followed by the ringing trip and back bridge relays. Immediately after the test is finished the main steerer is restored to normal as well as the subsidiary steerer and the associated switches SS1, SS2, SS3 and SS4. TF operates to preselect an idle trunk and the relays R1, R2 are released to connect up the calling line to the contacts of CF1 so completing the connection.

It should be noted that as the main steerer is only in use during the period of setting up a connection the switches MSS need only be provided at a rate of about two for 25 to 35 lines. Approximately 9-11 main steerers MS would be required per 1000 lines while the subsidiary steerers would be in the same proportion. In view of the large group of subscribers (1000) accessible to TR, the number of first selectors would be of the order of from 550 to 650. The cost compared with the use of line switches is reduced, while a considerable saving is the elimination of a large number of relays performing a very limited function. Again the switches become mechanisms purely and simply, and no longer a complicated circuit arrangement in addition, thus facilitating maintenance.

The main steerer and subsidiary steerer although comprising a number of relays need not be considered very complicated as they can conveniently be divided into clearly defined groups of counting relays and replacement of any particular group would be a very

simple matter. Having described the general arrangement, a description will now be given of the circuits used for setting up a call.

5 If there is an idle main steerer selector MSS available the subscriber on lifting his receiver completes a circuit for the line relay 10 as follows: earth on contact 49 or contact 50, contact 51, subscriber's loop, contact 52, relay 10
10 to battery. Relay 10 energizes and at 11 completes a circuit for relay R1 and at 12 prepares a circuit for cut off relay 13 which however is ineffective if contact 14 which first closes is connected over 15 to an earthed test
15 conductor 16 of the switch MSS which would be the case if the first switch was busy, as relay 13 will be short circuited. If the first switch is busy relay R1 on energizing prepares a circuit for relay R2 as follows: earth,
20 contacts 11, 17 and 18, relay R2 to battery. Relay R2 energizes and assuming the second switch MSS to be idle and no earth on test conductor 19, relay 13 will be no longer short circuited but will energize in series with resistance 20 and battery. If both switches
25 MSS are busy, contacts 49 and 50 will be both open so that the line relay cannot energize until one is free. This would only be rare occurrence as the group of subscribers' lines is small, and if it happened would last for
30 only a very short interval of time. Assuming however that the first switch is free, relay 13 will energize immediately and open the circuit of relay 10 at 51 and 52, so that this relay falls away shortly after, opens contacts
35 21 and 18, and closes contacts 22 and 23, thereby completing the following circuit for relay 24: earth, contacts 25, 26, 27, 22, subscriber's loop, contacts 23, 28, 29, 30, relay 24, battery.
40 Relay 24 energizes and connects earth to test conductor 16 at contact 35. Relay R1 is locked up to the test conductor 16 as follows: earth on conductor 16, 15, 32, relay R1, to battery. Relay R1 maintains relay 13 energized
45 over contact 34. All these holding circuits are completed before relay 10 falls away.

Relay 24 at contact 36 completes a circuit for relay 37 in series with stepping magnet 38 while at 39 the test wiper 40 is connected
50 to the junction point so that the stepping magnet is operated until an idle main steerer MS is found. When this occurs relay 37, which is no longer short-circuited operates and disconnects relay 24, connects up the line wipers 41, 42 at contacts 43, 44, closes
55 contacts 45, 46 so as to maintain earth on test conductor 16 and connects up the test wiper 40 from which earth is received back before relay 24 falls away. Relay 37 also
60 closes contact 47 to complete a circuit for an auxiliary relay 53. The impulse sender IS consists of a forwardly hunting switch having a semi-cylindrical contact bank with four sets of 25 contacts, the sets being arranged
65 in pairs and adapted to be wiped over

by two pairs of wipers diametrically opposite to each other so as to be equivalent to a 2 wiper 50 step switch.

The marking contacts of the impulse sender are connected up as regards the tens and units digits by the cut off relay 13 and relay R1 of the calling subscriber's line, over
70 contacts 54, 55, 56, and 57, 58, 59, while the thousands and hundreds digits are connected up by the relay 53 over contacts 60 and 61.
75

Before proceeding with the generation of impulses it will be best to refer to Fig. 5 from which it will be seen that line relay 62 energized in series with the calling subscriber's loop to wipers 41 and 42. Relay
80 62 on energizing completes a circuit for release relay 63 which on energizing connects earth to test wiper 40 at 64 to hold up the relays 37, 13, and R1 and at the same time closes contact 65.
85

Relay 62 to which a dial tone may conveniently be connected in known manner is now ready to respond to the impulses generated by the calling subscriber. At the same time impulses are generated by the impulse sender IS in accordance with the number of the calling party. The latter operation will be dealt with first although as the two operations in the present example can
90 take place at the same time, this is merely a matter of convenience. In other embodiments of the invention this latter operation may be deferred until one or more series of impulses have been generated by the calling party.
100

When relay 53 operated as previously described a circuit was closed as follows: earth, interrupter 66, contact 67, contact 68, relay 69 to battery. Relay 69 is thereupon intermittently energized. At contact 70 a circuit
105 is closed for magnet 71 of the impulse sender IS to step the wipers round. On the first interruption of the circuit of magnet 71 a circuit is closed on the next contact to normal for relay 72 as follows: earth, second contact
110 engaged by wiper 73, relay 72 to battery. Relay 72 energizes and at contact 73 removes earth from impulsing lead 74 connected over contact 76 to wiper 75 of switch MSS. It should be mentioned that relay 53 at contact
115 76 had previously completed a circuit from earth on contact 73 over the impulse lead and wiper 75 for relay 77. Relay 77 being slow to release remains energized as long as relay 69 is intermittently energized, due to the intermittent connection of earth at contact 78. When wiper 83 reaches the contact
120 marked by contact 61 relay 84 energizes and opens the circuit of relay 69 at contact 68, which due to its continued de-energization permits the release of relay 77. Relay 77 at contact 85 completed a circuit for the lower winding of relay 86 which partially energized sufficient to close contact 87 and connect the
125 release trunk conductor to its upper wind-
130

ing, so that on the de-energization of relay 77 and the consequent opening of contact 85, the two windings of relay 86 were energized in series and relay 86 fully energized to connect at contact 89 the impulse lead over back contact 88 to vertical magnet 80 of steer switch SS1 and over wiper 81 to magnet 82 of finder selector FS. At contact 90 a circuit is prepared for the partial initial energization of relay 79 which is a similar relay to relay 86. At the impulse sender 1S the relay 84 on energizing locked itself energized over contacts 91 and 92 and at contact 93 completed a circuit for magnet 71 from wiper 73 over contact 93, interrupter contact 99, magnet 71, to battery. Consequently the magnet rotates rapidly until wiper 73 reaches contact 100 from which earth has been removed at contact 101 of relay 53. When this contact is reached relay 72 becomes de-energized and releases shortly after being followed after another short interval by relay 84 when the original circuit for relay 69 is again completed at contact 68. The transmission of impulses then proceeds as before after the relay 72 has been energized on the completion of the first impulse, but this time the impulses besides controlling relay 77 also cause the magnets 80 and 82 to advance the wipers of the switches SS1 and FS to the sixth level. This is because the wiper 83 completes a circuit for relay 84 when six impulses have been generated and the same cycle of operations proceeds as before to advance the wipers to a normal position, the wipers 73 being now connected to contact 400. In the meantime relay 77 which was energized throughout the series of impulses had completed a circuit for the lower winding of relay 79 through contacts 85 and 90 which partially energized to close contact 104, to connect the upper winding to the release trunk conductor and fully energized from earth on contact 64, when relay 77 de-energized, through both windings in series. Relay 79 at contact 105 completes a circuit for relay 106 from earth, interrupter 107, contacts 108, 105, relay 106 to battery. Relay 106 energizes intermittently and on its first energization at contact 109 completes a partial energizing circuit for relay 110 which closes contact 111 connected to the release trunk conductor 112 which is earthed at contact 64. Relay 110 therefore energizes immediately after the first impulse is completed and prepares a circuit for rotary magnet 113 of switch SS1 and over wiper 114 for rotary magnet 115 of switch FS so that on the next impulse the wipers of both switches are stepped on to the first contact of the sixth level. At the same time a partial energizing circuit is prepared for relay 116 over contacts 117 and 118 which relay then closes contact 119 so that on the cessation of the next impulse, both its windings are energized in series from earth on lead 112. Relay 116

prepares the following test circuit, battery, resistance 120, contact 121, relay 122, earth, contact 121 being also connected over contact 123 to test wiper 124 of switch SS1. If the test wiper is connected to an earthed contact indicating that the first finder selector is busy then relay 122 is short circuited and the rotary magnets are energized again to step the wipers to the second contacts, and so on until an idle finder selector is found; when this occurs relay 122 energizes, closes contact 125 and disconnects contact 123. It also opens contact 108 and contact 126 so that neither the relay 106 nor the magnets 113 and 115 can be again energized. The wipers 127, 128, 129 of the switch FS are connected to contacts directly connected to the wipers 130, 131, 132 of a connector finder switch CF1 while the wipers 133, 134 of the switch SS1 are connected to contacts directly connected to the vertical and rotary magnets 135 and 136 of the same switch. The contact 124 is connected to a relay 137, which energizes immediately earth is placed on wiper 124, through off normal springs 138 and completes a locking circuit for itself at contact 139 independently thereof. Relay 137 also opens contacts 140 and 141 so as to disconnect the release magnet 142 and the test wiper 131.

As it is the multiples of the contact engaged by wiper 124 in the banks of the switches SS1 and SS4 which guard the connector finder switch CF1 from intrusion and further as when the switch CF1 is used as a connector the wiper 131 must be used to test if the wanted subscriber's line is free, whether the contact engaged thereby is connected to earth potential or not it will be clear that relay 137 by disconnecting the two multiple leads enables the different function served by the third conductor to be performed in a proper manner.

The rotary movement of the switches SS1 and FS takes place in the prearranged time interval which elapses before relays 72 and 84 de-energize to initiate the generation of the series of impulses determined by relay R1 and corresponding to the last two digits of the calling subscriber's number. These two series of impulses are generated in exactly the same manner as the first two except that wipers 102 and 103 become effective in the place of wipers 73 and 83.

The next series of impulses to that previously described now passes over wiper 75, to relay 77 as before and over contact 89, contact 143, contact 144, wiper 133, vertical magnet 135 to battery. Relay 77 causes the partial energization of relay 145 which is completed when relay 77 de-energizes and at termination of the series of impulses and at contact 146 transfers the impulsing circuit to wiper 134 and rotary magnet 136 so that the next series of impulses cause the wipers of the switch CF1 to be stepped on to the con-

tacts connected to the calling subscriber's line. When the impulse sender IS advances so that wiper 102 engages contact 251 and wiper 103 engages contact 252, relay 72 de-energizes, but relay 84 is maintained energized from contact 253 so that the further operation of IS is prevented. It will thus be appreciated that irrespective of whether the subscriber dials or not as soon as he lifts his receiver, his line is automatically associated with a trunk relay group over two serially related finder switches which differ from the ordinary finder in that they are operated in a similar manner to selector and connector switches and the arrangement of connection over contacts 54-59 renders it impossible for one calling line to intercept a finder operated slightly previously by another calling line.

All the usual problems of finder switches are eliminated and the operation is just as positive and certain as the operation of Strowger group selector and connector switches in use at the present day. The contact 101 is provided to connect earth to all intermediate contacts and leave only the first contact disconnected so as to ensure that if the subscriber hangs up before the finder switches have been operated, the impulse sender IS will restore to normal. The operation of the switches which connect up the wanted subscriber's line will now be described. The line relay 62 being energized over the calling subscriber's loop as previously described de-energizes in response to the operation of his dial switch. As the first digit to be dialled is seven, the line relay 62 will de-energize seven times, completing a circuit for relay 147 in parallel with vertical magnets 148, 149, 150 of the switches SS3, SS2 and GS respectively as follows: earth, contacts 243, 251, contact 65, relay 147 to battery, and contact 152, magnets 148, 149 to battery, and wiper 153 and vertical magnet 150 to battery.

Relay 147 prepares a circuit to cause the partial energization of first digit relay 154 while the switches SS3, SS2 and GS are stepped to the seventh level. On the termination of the seventh impulse, relay 154 fully energizes and at contact 155 closes the following circuits: battery, relay 156, contact 155, contacts 157 and 158 in parallel, interrupter 107 (although three interrupters are shown only one is necessary so only one reference is used for the three), earth. Relay 156 therefore energizes intermittently; on its first energization it closes a partial energizing circuit for relay 159, which fully energizes on the completion of the impulse. Relay 159 energizes so that on the next energization of relay 156, a circuit is completed as follows: earth, contacts 160, 161, 162, rotary magnet 163 of switch SS3 to battery, also over contact 164, rotary magnet 165 of switch SS2 to battery, also over wiper 166 to rotary magnet 160 of switch GS to battery. The

wipers of these three switches are therefore rotated step by step over their seventh levels.

When relay 156 is energized a second time it now closes a partial energizing circuit for relay 168 which energizes when relay 156 de-energizes and completes the following test circuits: earth, battery, resistance 169, contact 170, relay 171 to earth in parallel with contact 172 and test wiper 173 and earth, battery, resistance 174, contact 175, relay 176 in parallel with contact 177 and test wiper 178. As long as the test wipers are in connection with earthed contacts corresponding to busy lines, the relays 176 and 171 will be short circuited. As soon as wiper 178 reaches an idle line, relay 176 will energize, opening at contact 164 the impulsing circuit for rotary magnets 165 and 160 so that the switches GS and SS2 come to rest on corresponding sets of contacts on the seventh level. When wiper 173 reaches an idle line, relay 171 will energize opening at contact 162 the impulsing circuit for rotary magnet 163 so that the switch SS3 will be arrested. The extent of the rotary movement of switch SS3 is determined independently of the movement of switches GS and SS2.

Relay 176 by closing contact 179 connects guarding potential to wiper 178 and at the same time opens contact 177 to prevent it being short circuited. Relay 171 closes contact 180 to connect guarding potential to wiper 173 and at the same time opens contact 172 to prevent it being short circuited. At this instant the switch SS3 has selected an idle subsidiary steerer SS of the 7 thousands group while the switches SS2 and GS have established connection respectively with the driving magnets and speaking leads of an idle connector finder switch CFS having access to the subscribers' lines whose first digit is seven.

On the calling subscriber operating his dial switch for the second digit to send out six impulses, the line relay 62 responds and the impulses may then be traced over the following circuits, relay 154 being now fully energized: earth, contacts 243, 151, 65 to relay 147 which energizes and closes a partial energizing circuit for relay 181, also the impulsing circuit extends over contacts 182, 183, wiper 184 of switch SS2, vertical magnet 185 of switch CFS to battery, so that the wipers of this switch are stepped to the sixth level. The impulsing circuit also extends over wiper 186 of switch SS3, relay 187 to battery, while a branch extends over contact 188, vertical magnet 189 of switch SS4 to battery, so that the wipers of switch SS4 are also stepped to the sixth level. Now the connectors connected to the sixth level of SS4 are arranged to be the same connectors arranged in the same order as are connected to switch CFS, so that the number of steps taken by the wipers of SS4 to reach an idle connector will be equal

to the number of steps to be taken by the wipers of CFS to reach the same connector.

Relay 187 closes a partial energizing circuit for relay 190, which fully energizes when relay 187 falls away and closes the following circuit: earth, interrupter 194, contacts 191, 192, relay 193 to battery. Relay 193 energizes intermittently and on its first energization closes a partial energizing circuit for relay 195 which fully energizes on the subsequent deenergization and closes contact 196 so that on the next energization of relay 193 a circuit is completed as follows: earth, contacts 197, 196, 198, rotary magnet 199 to battery, while a branch of this circuit extends over wiper 200, wiper 201, rotary magnet 202 of switch CFS to battery. The two magnets step together until SS4 finds an idle connector finder such as CF2. The test circuit is prepared by relay 203 which energizes after the second impulse when the wipers of switches SS4 and CFS are resting on the first contacts in the level. This test circuit is similar to those previously described and consists of earth, battery, resistance 204, contact 205, relay 206 to earth, with a branch circuit extending over contact 207 to wiper 208. Relay 206 is therefore short circuited until an idle line is reached when it energizes, opens contacts 198 and 191 to disconnect the magnets and interrupter so that the wipers are brought to rest on corresponding contacts. Relay 206 by opening contact 207 and closing contact 209 disconnects itself from the test wiper 208 and connects guarding potential thereto from wiper 173. It will be noted that the relays 190, 210, 195 and 203 are held up in locking circuits. The detailed operation of these relays is not described in full as it is now well known.

As relay 181 energized fully on the termination of the second series of impulses, contact 183 is opened and the next two series of impulses are transmitted. Dealing with the tens digit (2) first, the impulsing circuit may be traced as follows: earth, contacts 243, 151, 65, 182, wiper 186, contacts 210, 211, wiper 212, vertical magnet 213, to battery; the switch CF2 is thereupon stepped to the second level. On the termination of this series of impulses relay 210 fully energizes and transfers the previously described impulsing circuit to wiper 214 and rotary magnet 215 to battery, so that the units digit then steps the wipers of the switch CF2 on to the contacts of the wanted subscriber's line.

At this time the switch CF1 will also have been set on to the calling subscriber's line. Now referring to Fig. 5, it will have been noted that the relay 154 fully energized after the first series of impulses and relay 181 after the second series of impulses. In a similar manner relay 216 is energized after the third series of impulses, and relay 217 after the fourth. Relay 217 closes contact 218 to test

the wanted subscriber's line. If the wanted line is busy the following circuit is completed: battery, resistance 219, contact 218, wiper 220, contact 232, relay E, contacts 221, 222, wiper 223, wiper 224, wiper 225, which is earthed under these conditions. It should be mentioned here that the connection of guarding potential to wiper 178 causes the energization of relay 226, over off normal contact 227 which relay at contacts 228 and 229 disconnects wiper 224 and release magnet 230 and prepared a locking circuit for itself at 231 independent of off normal contact 227. Similarly the connection of guarding potential to wiper 208 caused the energization of relay 232 over off normal contact 233, which relay at contacts 234 and 235 disconnects wiper 225 and release magnet 236.

This arrangement therefore ensures that the testing is direct and is not affected by any connections to the test leads of the intermediate switches, while at the same time the protection is guarded as all means of access are connected to earth potential. Relay E on energizing disconnects contact 220 at 232 and at 233 connects up battery through resistance 234 direct, at the same time it opens contact 221 and establishes a locking circuit for itself over contact 235, wiper 236, contact 237, earth (relay 238 being energized at the time the main steerer MS is selected as will be described later). At contact 239 busy tone is connected to wiper 129 and at contacts 240, 241, 242, the wipers 127, 128 and 129 are connected up. These operations are not effective in bringing about any definite result until another operation has taken place which will now be described. When relay 217 energized at the end of the last series of impulses contacts 243 and 244 were opened. The opening of contact 244 is without effect at this time as relay 238 is maintained energized independently thereof from earth on contact 64. The opening of contact 243 opens the circuit of release relay 63 so that contact 64 opens shortly after, while a circuit is prepared for the release magnets 245, 246, 247 at contact 248. The opening of contact 64 releases the relays 37, 250 and R1 (Fig. 2). Relay 37 opens the circuit of relay 53, which deenergizes and opens contact 253 and closes contact 101 and contact 400; magnet 71 is thereupon energized and the wipers of IS are advanced one step to normal. Relays 72 and 84 thereupon de-energize as they are now longer held up over contacts 251 and 252 respectively. Relay 250 de-energizes and connects earth to contact 49 so as to complete a point in the circuit of the line relays of the subscriber's group to which IS belongs. Relay R1 de-energizes but not relay 13 which is maintained energized over the following circuit: earth, contact 237, wiper 236, contact 241, wipers 128, 131, relay 13, resistance 20 to battery. Relay R1 at contacts 254, 255,

completes the following circuit for line relay A; earth, battery, upper winding of line relay A, contact 240, wipers 127, 130, contacts 254, 22, subscriber's loop, contacts 23, 255, wipers 132, 129, contact 242, lower winding of line relay A to earth. Relay A energizes and completes a circuit for relay B at contact 256, which relay energizes and at contact 257 connects earth to wiper 236 in place of the earth connection at contact 237 which is removed when relay 238 falls away a short while after contact 64 is opened. The opening of contact 64 causes the relays 154, 181, 216, 159, 168, 86, 79, 145, 116, 110 to de-energize. Relay 168 opens the circuits of relays 176 and 171 which also de-energize while relay 116 opens the circuit of relay 122 which de-energizes. The opening of contact 64 removes earth connection from wipers 124, 178, 173, thereby causing relays 137, 226 and 190, 210, 195, 203 and 232 to de-energize so that wiper 131 is connected to wiper 124 over contact 141, wiper 224 is connected to contact 178 over contact 228, and wiper 225 is connected to wiper 208 over contact 234. An extra relay 258 which is maintained energized by the closure of contact 64 is provided for opening the circuit of release magnet 259 of the switch SS4 so that it is also released at this time and completes a circuit as follows: earth, contact 260, off normal springs 261, release magnet 259 to battery. The release magnet energizes and restores switch SS4 to normal. The subsidiary steerer SS is therefore completely restored to normal. Relay 238 will now de-energize and complete a circuit for rotary magnet 265 as follows: earth, contact 257, wiper 236, contact 266, magnet 265 to battery; it also opens at 267 the circuit of relay 217. The de-energization of relay 217 completes a circuit as follows: earth, contacts 243, 151, 248, off normal springs 262, 263, 264, release magnets 245, 246, 247 to battery, switches SS1, SS2 and SS3 all restore to normal. Relay 217 also closes contact 244 so that a circuit is prepared for relay 238. The magnet 265 steps the wipers 114, 81, 236, 223, 163, 166 of switch TF until wiper 236 finds an unearthed contact, then relay 238 energizes in series with the rotary magnet 265 to connect earth to wiper 236 at contact 237 to prevent the idle trunk line found being seized by any other trunk finder. The main steerer and its associated switches are now restored to normal and as an idle trunk line has been preselected, everything is in readiness for the next call. The release of the main steerer and the removal of earth connection from the wipers 124, 178, 208 causes the relays 137, 226, 232 to release thereby completing the following circuits: battery, resistance 276, contact 140, off normal springs 277, release magnet 142 to earth, battery, resistance 278, contact 228, off normal springs 279, release magnet 230 to earth, and battery, resistance 280, contact 235, off normal springs 281, release magnet 236 to earth. Release magnet 142 cannot energize in this circuit as it is short circuited due to the connections over 141 with test wiper 223, which is earthed at contact 257. Release magnets 230 and 236 do however energize as the only earth connections to the contacts 228 and 234 are either over resistance 282 to wiper 225 or over the upper winding of relay F, and there is consequently no direct short circuit and the circuit is so designed that the release magnets can energize under these conditions. Consequently CFS and CF2 restore to normal. The subscriber on hearing the busy tone hangs up his receiver so that relay A and subsequently relay B fall away. The opening of contact 257 permits the release magnet 142 to energize, so that switch CF1 restores to normal, also relay 13 de-energizes and the subscriber's line circuit is restored to normal. The closing of contact 283 when relay B de-energizes, completes an energizing circuit for release magnets 284 and 285 as follows: battery, resistance 286, contact 283, off normal springs 287, release magnet 284, and off normal springs 288, release magnet 285 to earth. It will be noted that this circuit was completed before relay B energized after the switches FS and GS had stepped off normal but was ineffective owing to the earth connection over wiper 236. Relay D also releases so that everything is now restored to normal. So far consideration has only been given to the case of the wanted subscriber being busy, if however when his line was tested he was idle, no circuit would be completed for relay E. Relay E would however have been energized as follows in series with the cut off relay (corresponding to relay 13) of the wanted line, (for the sake of convenience the parts of the wanted subscriber's line will be given the same reference letters as the corresponding parts of the calling subscriber's line): earth on wiper 236, upper winding of relay F, contact 222, wipers 223, 224, resistance 282, wiper 225, relay 13, resistance 20 to battery. Relay 13 and relay F energize in series; relay 13 opens contacts 51 and 52 to cut off relay 10 and also opens contacts 21 and 18 and connects up wipers 289, 290, over contacts 22 and 254 and 23 and 255 respectively. Relay F closes contact 291 connecting direct earth from wiper 236 to wiper 223, and at contact 292 completes a locking circuit for itself, it also completes the following circuit for ringing current at contacts 293, 294, earth, generator GEN, contacts 295, 294, wipers 296, 297, 290, contacts 255, 23, wanted subscriber's loop, contacts 22, 254, wipers 289, 298, 299, contacts 293, 300, upper winding of relay D to battery. As the operation of the release of the steerer switches is dependent upon the lapse of a short time interval after the transmission of the last digit and is not dependent

in any way upon whether the wanted subscriber's line tests busy or not, the release of the steerer switches will proceed exactly in the same way as previously described. The only differences concern the switches used for the established connection. It will be noted that relay F closes contacts 301, 302, 303 in parallel with contacts 240, 241, 242, so that the same function is performed as regards connecting up relay A and the test conductor whichever relay is operated. Consequently the operation by which connection is established to the calling line is identical with that previously described. The switches CFS and CF2 do not restore to normal as the release magnets 230, 236 are short circuited by direct earth on contacts 228, 234, which may be traced from contact 257 or wiper 236. When the wanted subscriber answers, the ringing trip relay D energizes, locks itself energized at 304 and at 305 and 306 completes a circuit for the back bridge relay C over the previously traced circuit, including the wanted subscriber's loop. Conversation can now proceed, battery being fed to the two subscribers over relays A and C. When the conversation is finished, the release takes place as previously described in the case when the calling subscriber was busy, except in this case the opening of contact 257 removes the short circuit of the release magnets of switches CFS, CF2 which release and restore to normal. It will be noted that whatever should happen the release of the connections becomes ultimately dependent on relay A or relay 62; so that if the calling subscriber should hang up prematurely, everything will be restored to normal.

Having now particularly described and ascertained the nature of my invention and in what manner the same is to be performed, I declare that what I claim is:

1. In a telephone system, a switch having wipers adapted to be moved a variable distance to make contact with one set of a plurality of sets of contacts, a similar switch to a set of contacts of which the first switch is connected, an auxiliary switch and means for operating it in synchronism with said second switch, and controlling magnets for said first switch connected directly to contacts of said auxiliary switch independently of the wipers of said first switch.

2. In a telephone system, a directly controlled switch, a second directly controlled switch in serial relation therewith, and a third switch similar in capacity to and associated with said first switch to obtain direct access to the motor magnets of said second switch independently of the wipers of said first switch.

3. In a telephone system a switch having wipers adapted to be moved a variable distance to make contact with one set of a plurality of sets of contacts, a second switch

to a set of contacts of which the first switch is connected, an auxiliary switch similar in capacity to and operated in parallel with said second switch to obtain direct access to the motor magnets of said first switch independently of the wipers of said first switch.

4. In a telephone system, a group selector, a second group selector in serial relation therewith, a switch, means for temporarily associating said switch with said first group selector, means for setting said switch and said first group selector simultaneously, and a circuit extending over the wipers of said switch for controlling the operation of said second group selector independent of the wipers of said first group selector.

5. In a telephone system, a finder switch, a second finder switch accessible to the wipers of said first finder, a third switch, means for temporarily associating said third switch with said first finder switch, and circuits extending over the wipers of said third switch for controlling the operation of said second finder.

6. In a telephone system, a group selector having both directive and hunting movements, a final selector having two directive movements, said final selector being in serial relation with said group selector, a switch similar in capacity to said group selector, means for temporarily associating said switch with said group selector, and a circuit extending over the wipers of said switch for controlling the operation of said final selector independent of the wipers of said group selector.

7. In a telephone system, a group selector, a second group selector accessible to the wipers of said first group selector, a directly controlled switch, means for temporarily associating said switch with said first group selector, and a circuit extending over the wipers of said switch for controlling the operation of said second group selector independent of the wipers of said first group selector.

8. In a telephone system a finder switch, a second finder switch in serial relation therewith, a third switch directly controlled, means for temporarily associating said third switch with said first finder switch, and circuits extending over the wipers of said third switch for controlling the operation of said second finder.

9. In a telephone system, a group selector, a final selector in serial relation therewith, a directly controlled switch similar in capacity to said group selector, means for temporarily associating said switch with said group selector, and a circuit extending over the wipers of said switch for controlling the operation of said final selector independent of the wipers of said group selector.

10. In a telephone system, a switch, an operating magnet for switch, an auxiliary

switching device, directly controlled means for operating said device to connect up a control circuit to the operating magnet of said switch, directly controlled means for operating said magnet and means for releasing said auxiliary device independently of said switch.

11. In a telephone system, a selector switch, an auxiliary switch, means for effecting the operation of the two switches in unison, a talking circuit adapted to be extended over the wipers of said selector switch to a third switch and an operating circuit to be extended over the wipers of said auxiliary switch to the control magnets of said third switch.

12. A telephone system comprising a set of switches in use throughout a connection, a second set of switches in use only during the setting up of a connection, means for temporarily associating said second set of switches with said first set of switches and means for controlling correspondingswitches in each set to operate together to establish connection with the same switch in the first set.

13. A telephone system comprising a set of switches including a number of ranks of switches in serial relationship, a second set of switches also including a number of ranks of switches in serial relationship but one less than the preceding number of ranks, means for temporarily associating said second set of switches with said first set of switches only during the setting up of a connection, and means for operating switches in corresponding ranks of each set simultaneously.

14. In a telephone system, a train of switches in serial relationship, a train of auxiliary switches in serial relationship one less in number than the number of said first switches, means for temporarily associating each of said auxiliary switches with a corresponding one of said first mentioned switches, and a circuit extending over all said auxiliary switches in serial relationship to control the operation of the magnets of the last switch in said first mentioned train of switches.

15. In a telephone system, a switch over the wipers of which a talking circuit is adapted to be set up, an auxiliary switch, means for temporarily associating said auxiliary switch with said first mentioned switch and means for controlling said auxiliary switch to cause its wipers to take up a position corresponding to the position taken up by the wipers of the main switch.

16. In a telephone system, two switches in serial relationship, a plurality of operating magnets for each of said switches, means including a directly controlled switch for completing operating circuits for the magnets of said first switch successively, means including a second directly controlled switch for completing operating circuits for

the magnets of said second switch successively and an auxiliary switching apparatus embodied in a single unit adapted to associate both said means with said magnets only during the setting up of a connection.

17. In a telephone system a plurality of switches in serial relationship, operating magnets for each of said switches, a steering device for completing operating circuits for all said magnets successively, and means for associating said steering device with the magnets of said switches independently of any of the wipers of said switches.

18. In a telephone system, a first group selector, a second group selector and a final selector all in serial relationship, switch controlling means for said selectors associated with said first group selector, said means being normally arranged to effect both directive and hunting movement control as to any selector being controlled, progressively operated means also associated with the first group selector to respond on the operation of the first and second group selector successively, and switching means controlled by said progressively operated means to modify said switch control means to cause the same to effect only directive control over said final selector.

19. In a telephone system, a plurality of switches in serial relationship, operating magnets for said switches, a main steering device for completing operating circuits for some of said magnets successively, a subsidiary steering device accessible to said main steerer independent of said switches for subsequently completing operating circuits for other of said magnets successively and means for associating said steering devices with each other and with said switches temporarily during the setting up of a connection.

20. In a telephone system, a plurality of switches in serial relationship, primary and secondary operating magnets for each of said switches, a steering device for completing operating circuits for the operating magnets of each of said switches successively, and means for associating said steering device with the magnets of said switches temporarily during the setting up of a connection.

21. In a telephone system, a plurality of switches in serial relationship, operating magnets for said switches, a main steering device, a subsidiary steering device, a control circuit extending from the main steering device directly to the operating magnets of certain of said switches and a control circuit extending from the main steering device through the subsidiary steering device to the operating magnets of the last of said switches.

22. In a telephone system, a plurality of switches in serial relationship, operating magnets for said switches, a main steering device for completing operating circuits for some of said magnets successively, a subsidi-

ary steering device for completing operating circuits for other of said magnets successively and means for selecting an idle subsidiary steerer controlled from said main steerer independent of said switches.

23. A telephone system comprising a switch, a second switch, a third switch, controlling means for causing said first switch and said second switch to operate simultaneously to establish connection with said third switch, an intermediate switch for connecting the controlling means to said first switch and a second intermediate switch for connecting the controlling means to said second switch.

24. In a telephone system, a switch, means of access to said switch from the bank contacts of a preceding switch including talking leads permanently connected to the wipers of said first switch, a second means of access to said first switch including switch controlling leads, and operating magnets for said first switch connected directly to the switch controlling leads.

25. In a telephone system a group selector having movement in two stages, a magnet directly operated to control the selector for one stage of its movement, a magnet operated until an idle line is reached by the wipers of the selector to control the selector for the other stage of its movement, a means of access to said switch including the talking leads permanently connected to the wipers of said switch, and a second means of access to which both magnets are directly connected.

26. In a telephone system, a switch, an operating magnet for said switch, an auxiliary switching device, directly controlled means for operating said device to connect up a control circuit to the operating magnet of said switch and means associated with said control circuit for causing said operating magnet to move the wipers of said switch to an idle line of a group.

27. In a telephone system, a switch, an operating magnet for said switch, a second operating magnet for said switch, an auxiliary switching device, directly controlled means for operating said device to connect up control circuits to the operating magnets of said switch, directly controlled means for operating said first magnet over one of said control circuits, means associated with one of said control circuits for causing said second operating magnet to move the wipers of the switch on to an idle line of a group.

28. In a telephone system, three switches in serial relationship, two auxiliary switching devices similar in capacity to the first and second switches, respectively, control circuits extending from said auxiliary switches to the operating magnets of said second and third switches, respectively, and means operated due to the operation of the first switch for selecting the second auxiliary switching device.

29. In a telephone system, a step by step switch, a second step by step switch to a set of contacts of which the first switch is connected, an auxiliary selecting device operated step by step in unison with said second switch and controlling motor magnets for said first switch connected directly to contacts of said auxiliary selecting device independently of the wipers of said second switch.

30. In a telephone system, a step by step finder switch, a second step by step finder switch in serial relation therewith, a third switch, means for temporarily associating said third switch with said first finder switch, and impulsing circuits extending over the wipers of said third switch for controlling the operation of said second finder.

31. In a telephone system, a group selector, a final selector, a lead extending to said group selector over which the directive control of the group selector is effected, a second lead extending to said group selector over which the automatic control of the group selector to find an idle line is effected, two leads extending to said final selector over which different directive controls of said final selector are effected, controlling means through the intermediary of which both the group selector and final selector are operated, and steering means separate from said final selector by which all said leads are successively connected up to said controlling means.

32. In a telephone system, a group selector, a final selector, a lead extending to said group selector over which the directive control of the group selector is effected, a second lead extending to said group selector over which the automatic control of the group selector to find an idle line is effected, two leads extending to said final selector over which different directive controls of said final selector are effected, controlling means through the intermediary of which both the group selector and final selector are operated, steering means separate from said final selector by which all said leads are successively connected up to said controlling means, and means for associating said steering means with said group selector.

33. In a telephone system, a group selector, a final selector, a lead extending to said group selector over which directly controlled impulses are transmitted, a second lead extending to said group selector over which automatically controlled impulses are transmitted, two leads extending to said final selector over which different series of directly controlled impulses are transmitted and a steering means separate from said final selector by which all said leads are successively connected to impulsing devices.

34. In a telephone system, a group selector, a final selector, a lead extending to said group selector over which directly controlled impulses are transmitted, a second lead extend-

ing to said group selector over which automatically controlled impulses are transmitted, a lead extending to said final selector over which one series of directly controlled impulses is transmitted, a second lead extending to said final selector over which a different series of directly controlled impulses is transmitted, impulsing devices through the intermediary of which both the group selector and final selector are operated, and a steering means to which all said leads are connected and by which all said leads are successively connected to said impulsing devices.

35. In a telephone system, a group selector, a final selector, a vertical magnet and a rotary magnet for each of said selectors, impulsing devices, separate leads extending from said impulsing devices to said magnets, steering means by which said leads are successively connected to the impulsing devices, and means for associating said steering means with said selectors only during the setting up of a connection.

36. In a telephone system, a group selector, a final selector, a lead extending to said group selector over which the directive control of the group selector is effected, a second lead extending to said group selector over which the automatic control of the group selector to find an idle line is effected, two leads extending to said final selector over which different directive controls of said final selector are effected, controlling means through the intermediary of which both the group selector and final selector are operated, and steering means associated with said group selector by which all said leads are successively connected up to said controlling means.

37. In a telephone system, a plurality of switches in serial relationship, operating magnets for said switches, a main steering device for completing operating circuits for some of said magnets, successively, a subsidiary steering device for completing operating circuits for other of said magnets, successively, means for selecting an idle line in a group associated with said main steerer, means for selecting an idle subsidiary steerer from said main steerer and controlling means whereby the group selections and subsidiary steerer selection take place simultaneously.

38. In a telephone system, a plurality of switches in serial relationship, operating magnets for said switches, a main steering device for completing operating circuits for some of said magnets successively, a subsidiary steering device for completing circuits for other of said magnets, successively, said steerer comprising means for responding to and routing the various series of impulses received by said steerer, means for selecting an idle subsidiary steerer associated with said main steerer, and means operated on the reception of the first series for initiating the operation of said selecting means.

39. In a telephone system, a switch, a second switch having a movement in a plurality of stages connected to the bank contacts of the preceding switch, a switching device constituting the sole device permanently associated with the second switch which is operated after the switch has made an initial movement and a steering device associated with said first switch for preparing for the different stages of operation of said second switch.

40. In a telephone system, a relay responsive to individual impulses, a step by step switch having no impulse responding relay permanently associated therewith, a second switch having wipers over which said relay is connected with said first switch only during the setting up of a connection, and means for directly controlling said second switch to seize said first switch.

41. In a telephone system, a relay of the slow to release type, a step by step switch having no relays of the slow to release type associated therewith, and a hunting switch adapted to connect up said relay to control the release of said first switch only during the setting up of a connection.

42. In a telephone system, a relay adapted to prepare a fresh operating circuit after each series of impulses, a first and a second step by step switch each having two operating magnets, but no such relay associated therewith, and means for temporarily associating said relay with said switches to enable said magnets to be successively rendered operable.

43. In a telephone system, a relay responsive to individual impulses, a relay of the slow to release type, a relay responsive to individual trains of impulses, a step by step switch having no such relays associated therewith, two operating magnets for said switch, and a hunting switch by which said relays may be associated with said switch to effect the operation of the switch to guard the release of the switch during the impulse trains and to route the impulse control to the operating magnets of the switch respectively.

44. In a telephone system, a switch, an incoming lead for said switch for testing purposes, an incoming lead to said switch for guarding purposes, and means whereby after testing the placing of guarding potential on the test lead causes guarding potential to be maintained on the guard lead.

45. In a telephone system, subscribers' lines, a switch for directly connecting with any one of said subscriber's lines, a test lead for said switch, a guard lead for said switch, means for normally connecting said test lead and guard lead together and means operated due to the switch being taken into use to separate said leads so that they can each be used for their separate functions.

46. In a telephone system, a switch, two impulsing circuits extending over the wipers of

said switch, directly controlled means for transmitting impulses over one of said circuits in accordance with a digit in the number allotted to a subscriber and an automatically controlled impulse generator for transmitting impulses to said switch over the other of said circuits in accordance with the idle condition of a line in a group of lines.

47. In a telephone system, a switch, two impulsing circuits extending over the wipers of said switch, directly controlled means for transmitting impulses over one of said circuits in accordance with a plurality of digits in the directory number allotted to a called subscriber, and automatically controlled means for transmitting impulses over the other of said circuits in accordance with the idle condition of a line in a group of lines.

48. In a telephone system, a numerical switch, a second numerical switch in serial relation therewith, an auxiliary switch, a directly controlled switch, means for preparing for the operation of the control magnets of the first numerical switch, means for preparing for the operation of the control magnets of the second numerical switch, means operated when the first numerical switch is taken into use for connecting said first preparing means to said first numerical switch by said first auxiliary switch, and means operated when the second numerical switch is taken into use for connecting said second preparing means to said second numerical switch by said directly controlled switch.

49. In a telephone system, a switch, an operating magnet for said switch, a second operating magnet for said switch, a lead incoming to said switch for testing purposes, a second lead incoming to said switch for guarding purposes, a third incoming lead over which impulses are transmitted to operate said first operating magnet, and a fourth incoming lead over which impulses are transmitted to operate said second operating magnet to operate said switch to select an idle line in a group of lines.

50. In a telephone system, a two stage numerical switch, a second two stage numerical switch in serial relation therewith, means for preparing for the operation of the magnets controlling the two stages of movement of the first switch, means for preparing for the operation of the magnets controlling the two stages of movement of the second switch, means for associating said first preparing means with said first switch as the first switch is taken into use and directly controlled means for associating said second preparing means with said second switch as the second switch is taken into use.

51. In a telephone system, a two stage numerical switch, a second two stage numerical switch in serial relation therewith, means for preparing for the operation of the magnets

controlling the two stages of movement of the first switch, means for preparing for the operation of the magnets controlling the two stages of movement of the second switch, a directly controlled switch for associating said first preparing means with said first switch as the first switch is taken into use only during the setting up of a connection, and means for associating said second preparing means with said second switch as the second switch is taken into use only during the setting up of a connection.

52. In a telephone system, a two directional step by step switch, a second two directional step by step switch in serial relation therewith, two impulsing circuits for the magnets of the first step by step switch, two impulsing circuits for the magnets of the second step by step switch, a switch for associating said first two impulsing circuits with the magnets of the first step by step switch when the first step by step switch is taken into use and only during the setting up of a connection, and a directly controlled switch for associating said second two impulsing circuits with the magnets of the second step by step switch when the second step by step switch is taken into use and only during the setting up of a connection.

53. In a telephone system, a switch, two sets of incoming leads for said switch each set comprising only three leads, a test lead included in one of said sets of leads, and a guard lead included in the other set of leads.

54. In a telephone system, a switch, three leads incoming to said switch, controlling means for said switch controlled over all said leads to cause it to set its wipers on a calling line, controlling means for said switch controlled over exactly the same leads to cause it to set its wipers on a called line, means for associating the first controlling means with said switch when a line to which it has access is calling and means for associating the second controlling means with said switch when a line to which the switch has access is called.

55. In a telephone system, a switch, three incoming leads for said switch, controlling means for said switch controlled over all said leads for causing it to operate to perform one function, a second controlling means controlled over exactly the same leads for causing said switch to operate to perform a second function and means for temporarily associating over said leads only during the setting up of a connection, either one controlling means or the other controlling means with said switch causing it to function in accordance with the controlling means associated with it.

56. In a telephone system, a switch, controlling means for said switch to cause it to set its wipers on a calling line, controlling means for said switch to cause it to set its wipers on a called line, said last mentioned

means comprising an impulse sender for transmitting directive impulses to the magnets of said switch, and means for temporarily associating only during the setting up of a connection the first controlling means with said switch when a line to which it has access is calling and means for temporarily associating only during the setting up of a connection the second controlling means with said switch when a line to which the switch has access is called.

57. In a telephone system, a selector switch for connecting with idle trunk lines, a connector switch accessible to said selector over one of said trunk lines, controlling apparatus for said selector switch separate therefrom and controlling apparatus for said connector switch separate therefrom, said controlling apparatus being so designed that the operation of both the selector and connector switches is identical.

58. In a telephone system, a connector switch of the step by step type, a finder switch of the step by step type, apparatus for transmitting impulses to the magnet or magnets of said connector switch, but separate therefrom, apparatus for transmitting impulses to the magnet or magnets of said finder switch but separate therefrom, and means for releasing said apparatus from said switches as soon as the setting up of a connection is completed so that during the ensuing conversation said apparatus can be used to set up other connections.

59. In a telephone system, a switch, one means of access to said switch, a second means of access to said switch, controlling arrangements for said switch comprising a subscriber's dial associated with one means of access, other controlling arrangements comprising a register sender at the exchange, associated with the other means of access, the whole of the apparatus permanently associated with the switch being operated in an identical manner whichever means of access is used.

60. In a telephone system, an impulse sender a second impulse sender, automatic means for operating said first impulse sender to transmit a predetermined number of impulses, subscriber controlled means for operating said second impulse sender to transmit a predetermined number of impulses, and means to permit both impulse senders being operated simultaneously to control the setting up of a single connection.

61. In a telephone system, a step by step switch for establishing connection with a calling line, a step by step switch for establishing connection with a called line, a distributing apparatus by which impulses are transmitted to said switches simultaneously and separate and independent circuits extending from said distributing apparatus to said switches.

62. In a telephone system, a two directional

switch for establishing connection with a calling line, a two directional switch for establishing connection with a called line, a distributing apparatus by which impulses are transmitted to said switches and four separate and independent circuits extending from said distributing apparatus, two to the magnets of the first switch and two to the magnets of the second switch.

63. In a telephone system, a two directional switch for establishing connection with a calling line, a plurality of two directional switches in serial relationship for establishing connection with a called line, a distributing apparatus by which impulses are transmitted to said switches and separate and independent pairs of impulsing circuits extending from said distributing apparatus to each pair of magnets controlling said switches.

64. In a telephone system, a plurality of two directional switches in serial relationship for establishing connection with a calling line, a plurality of two directional switches in serial relationship for establishing connection with a called line, a distributing apparatus by which impulses are transmitted to said switches and separate and independent pairs of impulsing circuits extending from said distributing apparatus to each pair of magnets controlling said switches.

65. In a telephone system, an impulse sender adapted to generate series of impulses corresponding to a calling subscriber's number, an impulse responder for responding to series of impulses corresponding to the number of the called line which are generated by the calling subscriber, a switching device for associating said impulse responder with the calling subscriber's line and means for automatically associating the impulse sender with said impulse responder responsive to the operation of said switching device.

66. In a telephone system, an impulse sender adapted to transmit series of impulses corresponding to a calling subscriber's number, an impulse responder for responding to impulses generated by the calling subscriber, and means for automatically associating said impulse sender and said impulse responder simultaneously with a calling subscriber's line.

67. In a telephone system, a plurality of directly operated switches in serial relationship for establishing connection with a calling subscriber's line, an impulse sender, a hunting switch adapted to associate said impulse sender with the last switches of the series, and a lead or leads connected direct to the control magnet or magnets of the last switch of the series from the hunting switch whereby the impulse sender can transmit series of impulses directly to said magnet or magnets to set the wipers on contacts to which the calling subscriber's line is connected.

68. In a telephone system, a two directional switch, a second two directional switch in serial relationship therewith having access to the lines of calling subscribers, and an impulse sender automatically adapted to generate at least three series of impulses corresponding to a number allotted to a calling subscriber to control the movement of said switches and cause the wipers of the second switch to be set on the line of the calling subscriber.

69. In a telephone system, a two directional switch, a second two directional switch in serial relation therewith and having access to the lines of calling subscribers, and an impulse sender automatically adapted to generate three series of impulses corresponding to a number allotted to a calling subscriber, means for causing one of said series of impulses to operate said first switch, means for automatically causing the wipers of said first switch to connect with said second switch if idle, and means for causing the two remaining series of impulses to operate said second switch.

70. In a telephone system, a subscriber's line, a relay preselector individual to said line, an impulse sender to which said relay preselector has access, a hunting switch associated with said impulse sender, an impulse responder adapted to be connected to the subscriber's line when calling on said relay preselector and said impulse sender, means whereby said impulse sender can establish connection with the calling subscriber's line and means whereby the impulse responder can establish connection with the called subscriber's line.

71. In a telephone system, a calling and a called line, a first and a second series of switches, means controlled by an impulse sender at the exchange for operating said first series of switches to find said calling line, and means controlled by an impulse sender at the calling subscriber's station to operate said second series of switches to complete the connection from the calling to the called line.

72. In a telephone system, a calling and a called line, a first and a second series of switches, means controlled by an impulse sender at the exchange for operating said first series of switches to find said calling line, means controlled by an impulse sender at the

calling subscriber's station to operate said second series of switches to complete the connection from the calling to the called line, and means for operating both said senders simultaneously.

73. In a telephone system, a calling and a called line, a first and a second series of switches, means controlled by an impulse sender at the exchange for operating said first series of switches to find said calling line, and means whereby the operation of an impulse sender at the calling subscriber's station controls an impulse repeater at the exchange to cause the operation of said second series of switches to complete the connection from the calling to the called lines.

74. In a telephone system, switches, means for operating three of said switches simultaneously in setting up a connection, and means for releasing two of said three switches responsive to the establishment of the connection.

75. In a telephone system, switches, means for operating three of said switches simultaneously and in unison in setting up a connection, and means for releasing two of said three switches responsive to the establishment of said connection.

76. In a telephone system, a train of switches for extending a connection to a called line, and a plurality of other switch trains for use in controlling the switches of said first train in the establishment of said connection.

77. In a telephone system, a train of switches for extending a connection to a called line, and a plurality of other switch trains for use in controlling the switches of said first train, the total number of switch trains being equal to the number of switches in the first train.

78. In a telephone system, a train of switches for extending a connection to a called line, a plurality of other switch trains for use in controlling the switches of said first train, the total number of switch trains being equal to the number of switches in the first train, and the number of switches in each train except the first being one less than the number of switches in the preceding train.

Signed by me at London, England, this 10th day of October, 1924.

RICHARD MERCER.