

Dec. 10, 1929.

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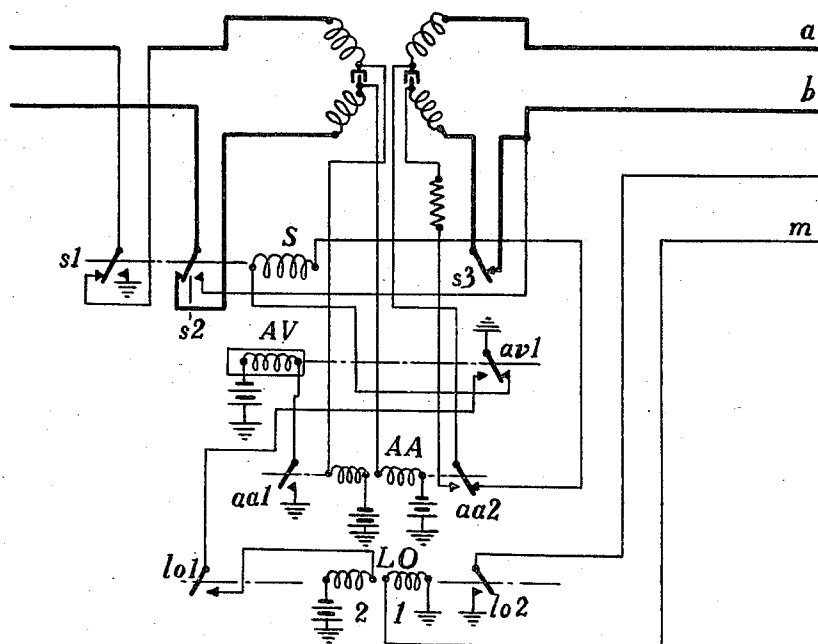
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TELEPHONE SYSTEM

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5 Sheets-Sheet 1

Fig. 1.



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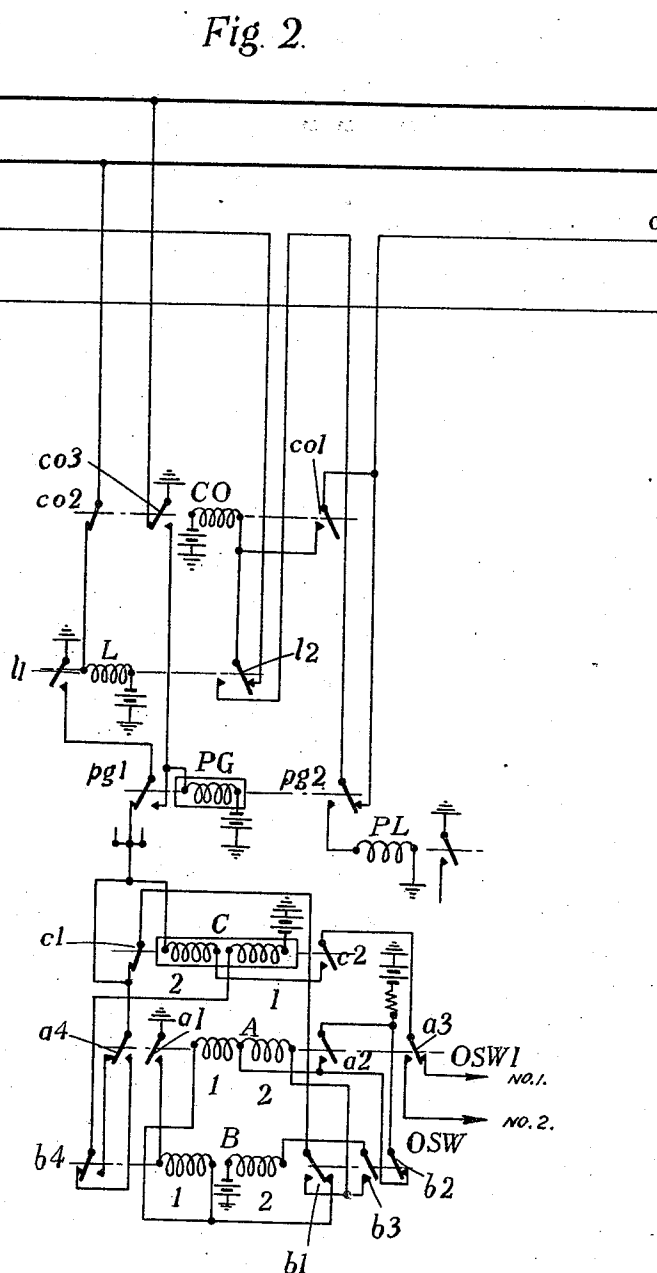
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Fig. 2.



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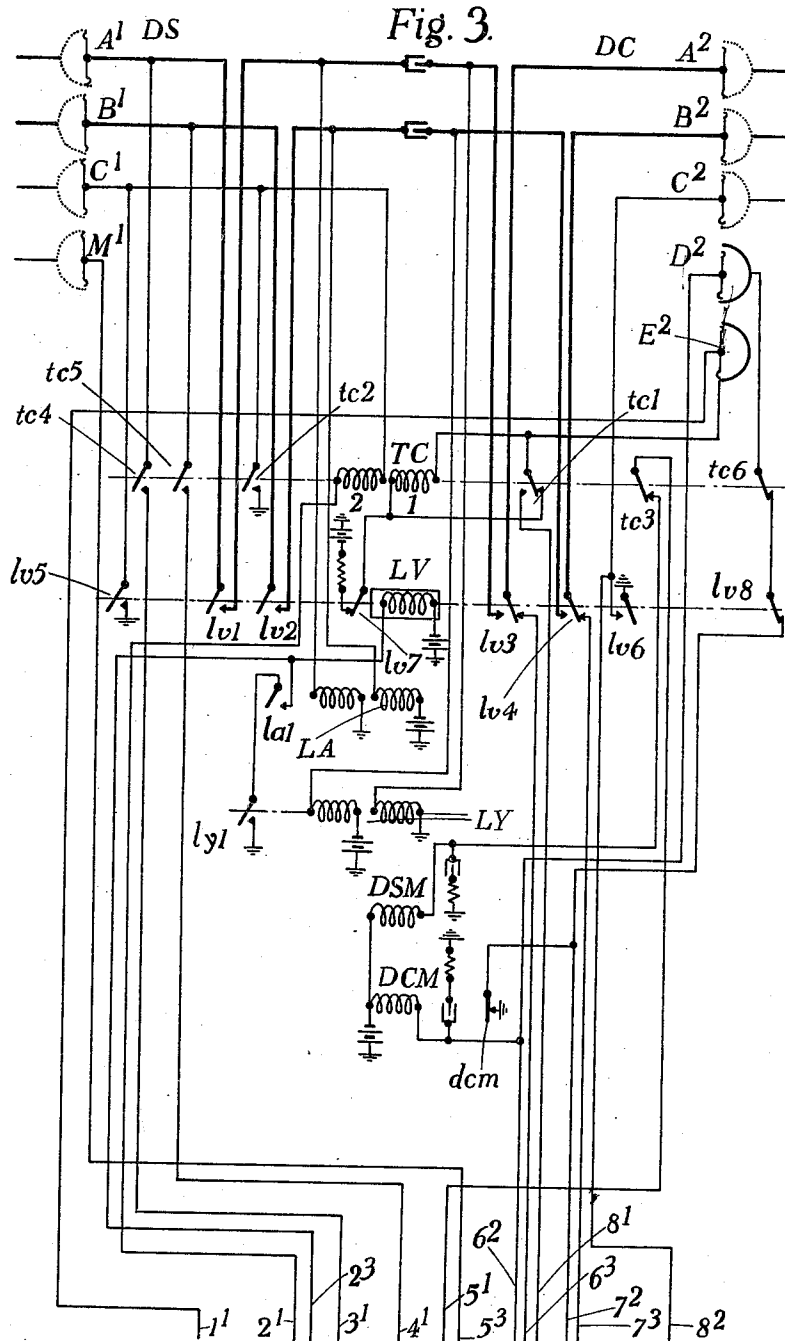
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TELEPHONE SYSTEM

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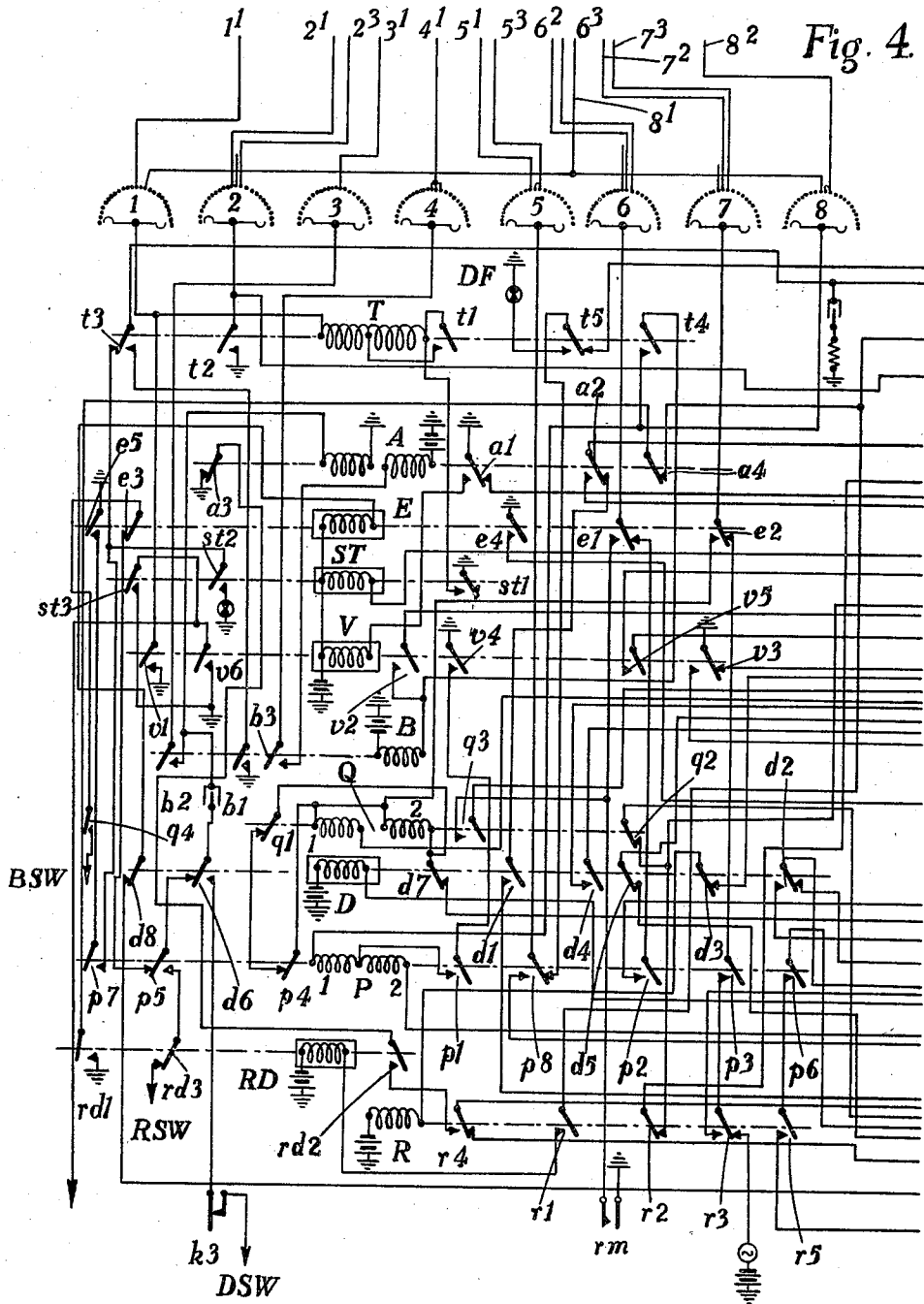
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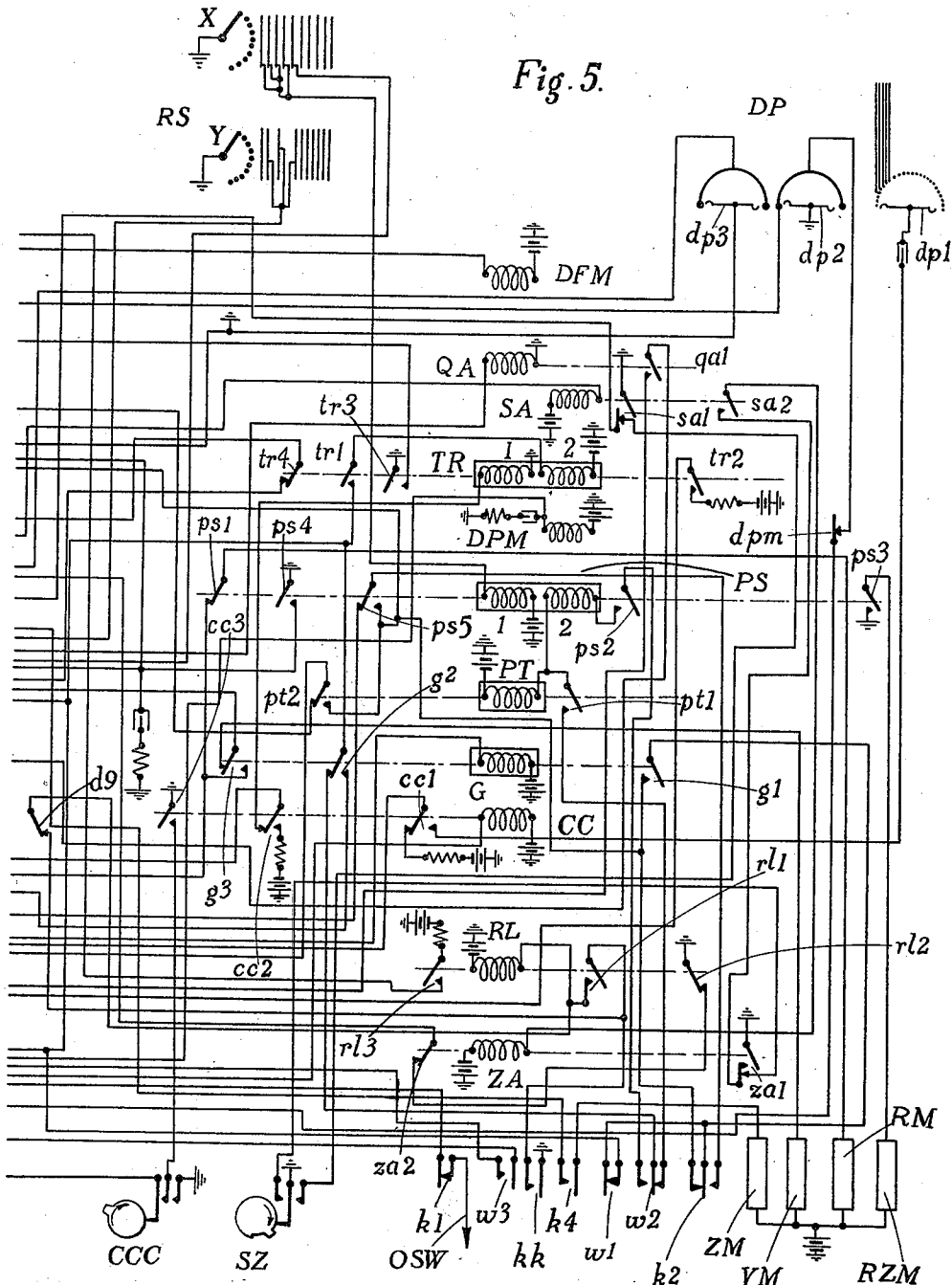
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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The present invention relates to automatic telephone systems and more particularly to systems including party lines.

In some systems of this kind subscribers connected to the same party line call each other by generators or other signalling means which do not involve the use of switches at the exchanges that are operated by dialled impulses. To avoid the difficulty that on an interparty call exchange apparatus common to a number of lines may be held unnecessarily, arrangements have been proposed to release exchange apparatus such as first selectors and to mark a line engaged if dialled impulses do not arrive in a predetermined period of time.

Whilst these arrangements serve the purpose in view, they do not distinguish between an interparty call and a permanent loop or line fault giving the calling condition.

The present invention has in view improved arrangements for providing for a throw-out of exchange apparatus normally seized in the case of a call between parties. An engaged marking may also be placed on the line.

In the present invention a subscriber desiring to call a party connected to his party line first dials a special number and then proceeds to call by his hand generator or other signalling means.

The effect of dialling the special number is to cause the exchange apparatus used in common to disconnect itself from the party line and to procure the sending of a signal to equipment individual to the party line which thereupon operates to prevent further common apparatus being seized. At the same time the individual equipment may provide for the placing of an engaged marking on the line.

The signal may be sent from an exchange selector or from a register-sender if the system employs the latter and obviously will only be sent if the selector or register has been set in accordance with the prescribed number.

The individual equipment receiving the signal may on operating provide for the holding of the cut off relay usually provided

which would normally release on disconnection of the apparatus used in common so that further common apparatus is not seized. Such cut off relay would be held operated so long as the calling condition of the line continued.

Using the method described for dealing with interparty calls, permanent loops or line faults giving the calling condition may be dealt with by the method involving non-receipt of impulses within a measured time.

In the case of rural party lines simplex dialling is generally employed and the party line, where it enters the exchange, is connected to a transmission bridge forming part of the line equipment. For the engaged marking in the case of an interparty call, we may provide in the line equipment a relay the circuit of which is made at the common exchange apparatus when the special number is dialled and this relay when operated may be locked up in a circuit including make contacts of the line relay on the incoming side of the transmission bridge or contacts of a relay controlled by the said line relays. The relay which is so locked up may be used to apply an engaged marking to the test or private wire of the line and at the same time complete a holding circuit for the test and cut-off relay of the line which relay is already operated consequent on access being given to the common exchange apparatus by the preselector of the line or by a finder switch.

In these circumstances the line equipment is in the condition taken up on an incoming call and the disconnection of the common exchange apparatus and the former holding circuit for the test and cut-off relay is without effect.

Since only a signal has to be passed back from the common exchange apparatus to the relay aforesaid, the disconnection of the apparatus may be directly due to the apparatus being brought to a prescribed position, slow release relays providing for the slight delay sufficient to cause the signal to be effective. The signal circuit may be entirely separate from the speaking and test circuits. It may be noted that the method above de-

scribed in which a special number is dialled allows the normal use of a dialling signal and disconnection thereof when a train of impulses has been dialled.

Line faults may be dealt with as follows:—

5 An additional line relay is provided on the outgoing side of the transmission bridge and a cut-off relay to disconnect the same from the line. A slow release "guard" relay is also provided, the circuit of which is made
10 when the cut-off relay operates.

This guard relay operating, prepares a holding circuit for itself including one of its make contacts and a make contact of the line relay. If there is a fault on the line and by
15 suitable arrangement the test wire is opened at the seized exchange apparatus after a prescribed interval, the cut-off relay will release and re-connect the line relay before the guard relay can release. It therefore will be held
20 dependent on the line relay being operated and may hold open a starting circuit for a finder or a preselector to prevent further seizure; and also close an alarm circuit.

25 Reference will now be made to the accompanying drawings which show by way of example an application of the invention to a system to which connections are ordinarily set up over a connecting circuit under the
30 control of a register controller or operator circuit temporarily associated therewith. For calls between parties on the same line the calling party rings the called party direct by means of a hand generator in accordance with
35 a predetermined code.

Figure 1 shows auxiliary apparatus connected to party lines between the main distributing frame and the multiple; Figure 2,
40 which should be placed to the right of Figure 1, shows a subscriber's line circuit and Figure 3, which should be placed to the right of Figure 2 shows a connecting circuit. Figure 4 which should be placed beneath Figure 3, and Fig. 5, which should be placed to the
45 right of Fig. 4, show an operator circuit for setting up calls between two subscribers.

A brief outline of the operation of the system will first be given followed by a description in greater detail of the various circuit
50 operations.

When a subscriber originates a call a signal is given to an assignor which has one of two operator circuits preselected and the starting circuit of the preselected operator, if idle, is
55 closed.

A link finder DF which also acts as a sequence switch is started in search of a free connecting circuit to the ends of which are connected a call seeker DS and a connector
60 DC. An idle connecting circuit having been found, the call seeker is started in search of the calling line to connect it to the operator. Dialled impulses from the calling subscriber's dial take effect on a two-motion recording
65 switch RS which is stepped vertically in ac-

cordance with the first digit and in a rotary direction in accordance with the second digit of a two digit number. When the number has been recorded the two-motion switch is stepped further, interacting with the driving magnet of the connector until a limiting or
70 "home" position is reached, the connector being simultaneously stepped. It is arranged that the number of further steps taken by the recording switch added to the number
75 representing its position in the bank makes up a given number. Consequently, the connector is stepped by a single impulse train over a number of contacts corresponding to the complement of the dialled number and is
80 thus set on to the contacts of the wanted line if the connector multiple is suitably arranged.

The link is tested in the usual manner, and if free the connection is switched through and the operator circuit freed for further use.
85

Arrangements are provided for the purpose of code ringing rural party lines.

The link finder serves as a sequence switch to connect in circuit the operating magnets of the call seeker and connector and to connect
90 the ringing current to the called line each at the appropriate time.

Referring to Figure 1, the auxiliary apparatus connected to the lines of party line subscribers includes a repeating coil with a line relay AA connected between battery and the two line wires. It is assumed that impulses from the subscriber's dial will be transmitted over a simplex circuit as is usual with such lines. To the exchange side of the repeating
95 coil is connected a relay S for cutting out the repeating coil while a party line subscriber is being rung. Relay LO is operated consequent on the receipt in the operator circuit of a special digit denoting an interparty call and locks up under control of relay AV. Relay LO connects earth to the test wire of the subscriber's line to hold the cut off relay and to mark the line engaged in the banks of the connecting switches.
100

In Figure 2 is shown the line circuit which comprises a line relay L, a cut off relay CO and relay PG, the function of which is to deal with faults on the line resulting in a line continuing in a calling condition. In
105 the lower part of the figure is shown an assignor common to a number of lines and comprises three relays A, B and C.

When a party line subscriber lifts the receiver to call, a simplex circuit is formed, current flowing to both line wires from the earthed positive pole of battery through the bell coils of the subscriber's instrument, and relay AA operates. Contact aa^1 operates relay AV and contact aa^2 short circuits the condenser connected to the exchange side of the repeating coil thereby providing a loop over which relay R operates. Contact l^2 connects battery over relay CO via contact pg^2 to the test wire c connected to the test bank contact of the call
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seeker DS, Figure 3, to mark the line as a calling line. Contact l^1 connects earth over contact pg^1 to relay A in the assignor. This circuit is as follows:—earth over contacts l^1 , pg^1 , cl , bl , winding 1 of relay A, contact b^2 to battery. Relay A operates and at contact a^1 connects winding 1 of relay B to earth. Relay B does not operate however, as it is short circuited. Contact a^2 closes to hold relay A against operation of relay B and contact a^4 closes a circuit from earth on the common connection from the line circuit over contact b^4 and winding 1 of relay C to battery.

Relay C operates and opens contact c^1 thereby permitting relay B to operate by means of its winding 1 in series with winding 1 of relay A.

Contacts b^1 and b^3 do nothing as contact c^1 is open and there is no circuit over windings 2 of relays A and B. Contact b^2 opening leaves relays A and B operated dependent on contact a^2 and contact b^4 opens the circuit of winding 1 of relay C. If operator No. 2 is engaged the circuit over wire OSW and the front contact a^3 will be open and relay C releases. Contact c^1 , falling back closes circuits in parallel for windings 2 of relays A and B, relay B holds over its contacts b^3 and b^1 already operated and relay A releases as its two windings oppose one another.

Relay A releasing contact a^2 opens to prevent operation of the relay by its winding 2. Contact a^4 falling back and contact b^4 being in its front position relay C again operates and tests operator No. 1 over back contact a^3 . If operator No. 1 is free relay C holds from battery connected in the operator circuit over wire OSW¹, back contact a^3 , contact c^2 , winding 2 of the relay, and contacts pg^1 and l^1 . A signal is thus transmitted to the operator to start to perform its functions. Contact c^1 opening, relay B releases and opens the circuit of winding 1 of relay C. Relay C continues to hold until the calling line has been found by the call seeker of the connecting circuit taken into use by the operator.

If operator No. 2 had been free when tested relay C would have remained held by its second winding and relays A and B would be held by means of their windings 1. When the calling line is found in this case relays A and B do not release but when another line calls relay B is held operated over its winding 2, and winding 2 of relay A energizing in parallel therewith the latter relay releases and operator No. 1 is tested as above described.

When the calling line is found by the call seeker of the link circuit taken into use by the assigned operator circuit, relay CO operates to earth connected over the test wiper of the call seeker and wire c and locks thereto over its contact co^1 . Contact co^2 disconnects relay L from the calling line and contact co^3 operates relay PG.

The operation of this relay and the release

of relay L opens the assignor circuit and the starting circuit of the operator.

Dialled impulses are repeated at contact aa^2 to the impulse relay in the associated operator circuit.

If the call is an interparty one a special one digit number is dialled which results in a battery connection to wire m being made in the operator circuit and relay LO is operated by means of its winding 1. This relay locks up by means of its winding 2 over contacts Lo^1 and av^1 and at contact lo^2 connects earth to wire c . As a further result of dialling the special digit the operator circuit is released and the ordinary holding circuit of relay CO is opened, but the cut-off relay remains held over contact lo^2 over which earth is connected to mark the line engaged in the subscriber's multiple.

In the case of a call completed through the exchange relay CO releases when either party clears. In the case of an interparty call when both parties have replaced their receivers relay AA releases and releases relay AV which in turn releases relay LO. Contact lo^2 opening, relay CO releases and the engaged marking is removed from the multiple.

When relay CO operated contact co^3 closed a circuit for relay PG which operated. Whilst a call is in progress relay CO remains operated and relay L is cut off the line so that there is no circuit over contact pg^2 for alarm relay PL.

Should a line fault develop and result in an operator circuit being taken into use relays AA, L, CO and PG operate as for a calling line and after a prescribed interval, should the operator circuit seized be still held, relay CO is released in a manner to be described later. Relay L thereupon re-operates and relay PG remains held over contacts l^1 and pg^1 . A circuit is closed from battery over relay CO, contact l^2 and pg^2 and relay PL, the latter relay operating and closing an alarm circuit. The line is prevented from connection with the exchange so long as the calling condition persists.

In the case of an incoming call relay CO operates in series with the test relay for the connector, cuts relay L off the line and operates relay PG. When the code ringing generator is applied to ring the called line, battery is connected to the a wire and relay S operates over contacts aa^2 and av^1 .

Contact s^1 connects the subscriber's a wire to a suitable return circuit and the ringing current is sent out over the b wire and front contact s^2 . Contact s^3 disconnects the exchange side of the repeating coil from the b wire. Relay S releases during the interval between successive applications of the ringing code. When the called subscriber lifts his receiver to reply relay AA operates in an interval between successive applications of the ringing code and contact aa^2 disconnects

relay S and loops the line to the exchange operating the ring tripping relay in the operator circuit which effects the switching through of the connection.

Referring to Figure 3 the connecting circuit comprises a call seeker DS and a connector DC, the stepping magnets of which are denoted by DSM and DCM respectively. TC is the test relay of the call seeker which is of the type in which the wipers after use remain in the position in which they were last used. The call seeker is provided with 4 wipers and banks, wipers A¹ and B¹ being the speaking wire wipers. C¹ the test wiper and M¹ the metering wiper. A meter is provided for ordinary subscriber's lines but in the case of party lines the bank contacts of wiper M¹ are connected to relay LO in the subscriber's auxiliary apparatus. The connector is a single motion switch of the homing type provided with 5 wipers and banks, wipers A² and B² being in the speaking circuit, C² being the test wiper and D² the homing wiper.

Current during conversation is fed to the calling line over relay LA and to the called line over relay LY. LV is a switching relay. In the designation of the wires to the contacts in the banks of the connecting circuit finder at the foot of the figure the index numeral represents the position of the wiper on the successive contacts associated with a connecting circuit over which the wire is first used.

Figures 4 and 5 show the operator circuit. The operator circuit has associated with it a finder DF the function of which is to search for an idle connecting circuit. Its stepping magnet is designated DFM.

Three consecutive contacts in its banks are associated with the same connecting circuit. Over the first of these contacts the test for a free connecting circuit is made and the driving magnet of the call seeker is operated. When the calling line is found the link finder is stepped to the second of the 3 contacts associated with the particular connecting circuit. In this position impulses from the calling subscriber's dials are repeated to the magnets of a two-motion recording switch RS, the wipers of which are set in accordance with the two digits representing the number of the called subscriber's lines. Switch RS is provided with 2 sets of wipers and banks X and Y and is operated by a vertical magnet VM, and a rotary magnet RM. A release magnet ZM is provided and also a magnet RZM which releases the wipers as regards their rotary motion only. The connector magnet DCM, Figure 3, is operated in the second position of the link finder by interaction with magnet RM of the recording switch until the desired line is reached whereupon a test of the line is made by relay P and if it is free the link finder moves to the third set of contacts associated with the particular connecting circuit and ringing current is connected to the called

line. Ring tripping relay TR is included in the ringing circuit and operates when the called subscriber replies, to close the circuit of switching relay LV.

In the operator circuit ST is the starting relay, T the test relay for the link finder, and P the test relay for the connector. A is the impulse relay, V the release relay, D the dialling relay which determines the end of an impulse train and G a steering relay which connects in circuit the appropriate operating magnet of the recording switch RS. PS and PT are relays concerned with the release, as far as rotary motion is concerned, of switch RS during its interaction with the connector driving magnet and Q is a relay which limits the stepping of switch RS in its transmission of impulses for the setting of the connector. Relay RL is concerned with the release of the operator and connecting circuits during interparty calls. The function of other relays will be clear from the following description which will cover the operation of the finder and connecting circuit Figures 3, 4 and 5 being taken together.

When the assignor receives a signal from a line circuit that a call has been originated, earth is connected to the operator circuit starting wire OSW which extends over vertical off-normal contact *h*¹ of switch RS, contacts *d*⁵, *tr*⁴ and relay ST to battery. Relay ST operates and at contact *st*¹ prepares the circuit of the link finder test relay T. Contact *st*³ starts a motor driving the interrupters and ringing generator and cams. Contact *st*² connects earth over an interrupter and back contact *t*³ to magnet DFM which operates and steps the wipers of the link finder in search of a free connecting circuit, a free connecting circuit being denoted by battery potential on wire 1¹ connected in the bank of wiper 1 of switch DF. When such a contact is encountered, relay T operates in a circuit from earth over contact *st*¹, its high and low resistance windings in series, wiper 1 and bank contact, wire 1¹, wiper E² of connector DC in its normal position, bank contact, contact *tc*¹ of relay TC, contact *lv*⁷, resistance to battery. Contact *t*³ disconnects magnet DFM from the interrupter and the finder comes to rest. Contact *t*¹ short circuits the high resistance winding of relay T to mark the connecting circuit engaged and contact *t*² prepares the test circuit of the call seeker of the seized connecting circuit. Contact *t*² connects an earthed interrupter over back contact *p*⁸, wiper 5 of switch DF on the first contact associated with the seized connecting circuit, wire 5¹, contact *tc*³, magnet DSM to battery. Magnet DSM operates and rotates the wipers of the call seeker in search of the calling line which is marked by the connection of battery over the cut-off relay in the line circuit to the bank of wiper C¹. When the contacts connected with the calling line are

reached relay TC operates in series with the cut off relay, over the bank contact of wiper C¹ to the earth connected over contact *t*², wiper 2 of switch DF and wire 2¹. Back contact *tc*¹ opens before contact *tc*² closes and winding 1 of relay TC is connected in series with relay T. Contact *tc*² connects earth directly to wiper C¹ to mark the line engaged to connectors of other connecting circuits and to hold the connection. Contact *tc*³ opens the call seeker driving magnet circuit. Relay B operates over contact *t*⁴, wiper 8, wire 8¹, front contact *tc*¹, normal contact and wiper R², wire 1¹, wiper 1, low resistance winding of relay T, contacts *t*¹ and *st*¹ to earth. Contacts *b*² and *b*³ connect the incoming speaking wires over wipers A¹, B¹, contacts *tc*⁴ and *tc*⁵, wires 3¹ and 4¹, wipers 3 and 4 of switch DF to relay A. Contact *b*¹ connects earth over front contact *t*³ to magnet DFM and the magnet attracts its armature. Relay A operating the circuit of relay V is closed at contact *a*¹ and relay V operates and closes a holding circuit for relay B over contacts *v*², *za*² and *rl*². Meanwhile relay CO has operated in the line circuit and released relay L and the starting circuit has been opened at the assignor. Relay ST thereupon releases and releases relay T. Contact *t*³ falling back opens the circuit of magnet DFM, contact *st*² by this time being open, and the connecting circuit finder wipers are stepped to their second position. In this condition relay TC remains held over front contact *tc*¹, wire 8¹, wiper 1 to earth connected thereto by contact *v*¹.

Further results of the operation of relay V are the operation of relay D in a circuit over contact *pt*², *a*² (operated) *k*², *w*¹ and *v*³; the preparation of the circuit of the first of a pair of slow alarm relays SA at contact *v*⁵, and the maintenance of the motor starting circuit at contact *v*⁶.

Relay D operating prepares a holding circuit for itself during impulsing at contact *d*¹ and at contact *d*⁶ connects dialling signal over wire DSW and contact *k*³ to the incoming line. Contact *d*⁴ prepares the circuit of vertical magnet VM and contact *d*⁵ opens the starting circuit to prevent seizure by another calling line.

The subscriber hearing the dialling signal commences to dial the wanted subscriber's number which consists of two digits for an ordinary subscriber and three digits for a party line subscriber. It will first be assumed that the wanted subscriber is an ordinary subscriber and not one on a rural party line. Dialed impulses are received by relay A and are repeated over contacts *a*¹, *d*⁴, *g*³ to the vertical magnet VM. Contact *a*² in its back position closes the holding circuit of relay D.

At the first vertical step the vertical off-normal contacts *k*¹, *k*², *k*³ and *k*⁴ are operated. The first of these contacts when operated

holds open the starting circuit preventing further seizure of the circuit while switch RS is away from its normal position. Contact *k*² prepares a circuit for relay G which operates at the end of the first train of impulses and contact *k*³ disconnects dialling signal. The wipers of switch RS are stepped vertically in accordance with the first digit dialled and at the end of the impulse train, relay A remaining operated, relay D releases and at contact *d*² the following circuit is closed; earth over contacts *v*³, *w*¹, *k*², *ps*⁵, *d*², relay G to battery.

Relay G operates and at contact *g*¹ closes a circuit as follows:—

Earth over contacts *v*³, *w*¹, *g*¹, *a*², *pt*², relay D to battery.

Relay D operates and at contact *d*² closes a holding circuit for relay G over contacts *g*² and *v*³. Contact *g*³ connects the rotary magnet RM in place of the vertical magnet VM. Contact *d*⁷ disconnects relay Q from the rotary magnet and contact *d*⁸ opens to delay the operation of relay E. The second train of dialled impulses is repeated over contacts *a*¹, *d*⁴, *g*³, *ps*¹ to the rotary magnet which steps the wipers round the level. At the first rotary movement rotary off-normal contacts *w*¹, *w*² and *w*³ are operated and at the end of the train the circuit of relay D now being open, that relay releases and a circuit is closed for relay E over contacts *d*⁸, *w*³, *g*² and *r*². Relay G releases. Relay E operates and closes a circuit from earth over armature contact *dcm* of the connector magnet, wire 7², wiper 7 in its second position, contacts *e*², *p*¹, *g*¹, *d*⁷, *ps*¹, magnet RM to the battery. Magnet RM operates and advances its wipers one step. Towards the end of its stroke armature contact *rm* closes and magnet DCM of the connector operates over wire 6², wiper 6, front contact *e*¹ and contact *rm* and towards the end of its stroke opens its armature contact *dcm* releasing magnet RM. The armature of magnet RM falling back contact *rm* opens the circuit of magnet DCM which thereupon releases and advances the wipers of the connector one step into the bank. Magnet RM continues to step, interacting with the connector magnet until the tenth contact in the level is reached.

A limiting or home position is provided on the recording switch to limit the stepping of the switch and of the connector. This position is such that when the recording switch is set by dialled impulses to the first contact in the first level, the subsequent stepping of the recording switch to the limiting position by its interaction with the connector magnet results in the stepping of the connector to the last bank contact to which lines are connected. For instance if the connector has 49 lines connected to its banks, the limiting position on the recording switch will be the tenth contact in the fifth level. This may

readily be ascertained if it is considered that by dialling 11, the two digit number that effects the setting of the recording switch on the first contact in the first level, the subsequent stepping by interaction over that level will result in 9 steps being taken to reach the tenth contact in the level. The switch is then released as regards the rotary position of the wipers and is given a vertical step and stepping continues over the second and subsequent levels until contact 10 in the fifth level is reached by which time the total number of steps taken by the recording switch and consequently by the connector will be 49. It will thus be seen that the lines in the connector banks are numbered backwards beginning with the highest subscriber's numbers, 59 in the above example and ending with 11.

A relay Q is connected to the limiting position in the bank of wiper X of the recording switch and a relay PS is connected to the tenth contact of all levels in the same bank reached by the wiper before that in which relay Q is connected.

When the recording switch is stepped to the tenth contacts of a level other than the limiting or home level, relay PS operates by means of its winding l over wiper X and at contact ps^1 opens the circuit of magnet RM. A circuit is closed for relay PT in series with winding 2 of relay PS, contacts ps^2 , w^2 , g^2 and v^3 . Contact ps^3 closes the circuit of rotary release magnet RZM which operates and returns the wipers to the rotary normal position whereupon the rotary off-normal contacts are restored. A circuit is now closed for relay PT over contact pt^1 and front contact w^2 independently of relay PS which releases after a short interval. Meanwhile relay D re-operates in a circuit over front contacts pt^2 , ps^5 , k^2 , contacts w^1 and v^3 and at contact d^4 closes a circuit from earth over contacts ps^4 , d^4 , g^3 for the vertical magnet VM. The magnet operates and the wipers are stepped to the next level, the magnet circuit being opened on the release of relay PS. The release of relay PS brings about the release of relay D at contact ps^5 and the stepping circuit of magnet RM is again closed. Relay G re-operates and releases relay PT at contact g^2 but itself is subsequently released due to the opening of contact w^1 when the wipers are stepped by the operation of magnet RM. Relay E holds operated during the rotary release and subsequent vertical step.

Interaction of the two magnets continues until the limiting position on the recording switch is reached whereupon on the opening of contact dem magnet RM is held momentarily in series with relay Q, winding l to earth over wiper X. Relay Q operates and at contact q^1 connects a high resistance winding 2 in the magnet circuit and the current being thereby reduced, magnet RM releases. Re-

lay Q now holds by means of its winding 2 and at contact q^3 connects relay QA over front contact e^1 , wiper 6 and magnet DCM which releases and advances the wipers one step. The connector wipers will now be found to be set on the contacts of the wanted subscriber's line.

Relay QA operates and at contact qa^1 completes the test circuit. If the line is free relay P operates from earth over contacts e^4 , qa^1 , windings 2 and 1 of relay P, wiper 8 of the switch DF, wire 8² and wiper C² of the connector to battery over the called subscriber's cut off relay and short circuits its high resistance winding 2 at contact p^1 thereby marking the line engaged. Operation of relay Q opens the circuit of relay E at contact q^2 and the slow release of relay E provides an interval for a fleeting test of the line. The subsequent release of relay E disconnects relay QA. Before the release of relay E however, and consequent on the operation of relay P, magnet DFM receives an impulse over contacts t^3 , p^1 and e^5 and the switch DF is stepped to its third position.

Relay F being operated contacts p^2 and p^3 close the ringing circuit which is as follows: battery over ringing generator, contacts r^4 , p^3 , e^2 , wiper 7 in position 3, wire 7³, contact lv^4 , wiper B², the called subscriber's line and bell, wiper A², contact lv^3 , wire 6³, wiper 6, contacts e^1 , p^2 , cc^2 , winding l of relay TR to earth. The called subscriber's bell is rung and a ringing signal is connected to the calling line over wire RSW, contacts rd^3 , p^5 , d^6 , b^2 , wiper 3 and contact tc^4 .

When the called subscriber lifts his receiver to reply the line is looped and relay TR operates in the circuit above traced and locks by means of its winding 2 over contacts tr^1 and v^3 . Contact tr^2 operates relay LO, Fig. 1, over front contact p^8 , wiper 5 and wire m but this relay performs no useful function in this connection. Contact tr^3 connects earth to wiper 2 and relay LV operates over wire 2³ and at contacts lv^5 and lv^6 connects earth directly to wipers C¹ and C² to mark both the calling and called lines busy to other connecting switches after the operator has been released. Contact lv^6 short circuits relay P which thereupon releases. Current is fed to the calling line over relay LA and contacts lv^1 and lv^2 and to the called line over relay LY and contacts lv^3 and lv^4 .

Relay LV locks up over contacts la^1 and ly^1 and at contact lv^7 opens the circuit of relay TC which releases. Contact tc^6 falling back prepares the homing circuit of the connector.

Consequent on the opening of contacts tc^4 and tc^5 relay A releases and at contact a^1 releases relay V. Relay V releasing releases relay B at contact v^2 and relay TR at contact v^3 and contact v^5 opens the circuit of relay SA releasing that relay should it be operated and contact v^6 opens the motor start circuit.

Contact r^3 falling back closes the circuit of the release magnet ZM and the magnet operates and releases the recording switch, the magnet circuit being opened by the opening of contact h^4 when the normal position is reached.

Release of the switch releases relay Q and the starting circuit is prepared for subsequent seizure of the operator circuit by the closure of contact h^1 .

At the end of the conversation the first subscriber to clear releases relay LV at contact la^1 or ly^1 as the case may be. Relay LV disconnects both feed relays from the lines and removes the busy markings on the test wipers of the connecting switches. Contact lv^8 closes the homing circuit of the connector over wiper D² and contacts tc^6 and dcm and the connector is returned to normal whereupon the link finder test circuit is again prepared over wiper E² in its normal position and contacts tc^1 and lv^1 .

Should the line when tested be found busy relay P does not operate and on the release of relay E following the operation of relay Q which determines the end of the stepping of the connector, a busy signal is transmitted to the calling subscriber over wire BSW, contacts q^4 , e^2 , p^5 , d^6 , b^2 , wiper 3 and contact tc^4 . When the calling subscriber hears the busy signal he replaces his receiver releasing relay A which brings about the release of the operator as previously described.

If a call is made to a subscriber connected to another rural party an additional digit is dialled for the purpose of connecting the appropriate ringing code to the called line in place of the usual interrupted ring. For this purpose an additional bank and wiper Y is provided on the recording switch.

Contacts in the bank corresponding to party line subscribers are connected to a relay E which disconnects the ordinary ringing circuit and connects this circuit over a single motion switch DP to a code ringing cam selected by the switch DP in accordance with the additional digit.

At the end of the second train of impulses contact d^3 connects relay R over the bank contact and wiper Y to earth. Relay R operates and at contact r^3 disconnects the ringing generator from the ringing connection to wiper 7. Contact r^1 operates relay RD over normal bank contact and wiper dp^2 and this relay prepares a locking circuit for itself at contact rd^1 . Contact r^2 opens to delay operation of relay E, contact d^8 being late in closing. The third digit is now dialled and is repeated over contacts a^3 , rd^2 , r^4 to magnet DPM of the single motion switch. Switch DP is stepped in accordance with the third train of dialled impulses. During impulsing relay RD holds over contacts r^1 , a^4 and rd^1 and at the end of the train,

releases. As soon as switch DP is stepped from its normal position relay E operates over contacts d^8 , w^3 , q^2 , off-normal segment and wiper dp^3 and closes the stepping circuit for the connector and relay RD is left dependent on contact a^4 .

When the wanted line is tested and found free relay P operates and locks up and at contact p^6 connects relay CC over contact r^5 to a code control cam CCC. This cam has a nose which when it is brought into contact with the inner spring associated with the cam, closes both the contacts and connects earth directly to relay CO over contacts r^6 and p^6 . Relay CO operates and on the passing of the cam nose, the inner spring rests on a surface of a radius sufficient to open the outer contact, yet maintain connection with the centre contact. In this position relay CC holds to earth connected over contact cc^3 . During the operated period of relay CC the code ringing generator is connected over the appropriate cam, bank and wiper dpl , front contacts cc^1 , r^3 , and p^3 and back contact e^3 to the outgoing b wire over wiper 7. Contact cc^2 disconnects winding l of relay TR and connects battery to the a wire for the purpose of operating relay S in the auxiliary line equipment to bridge the repeating coil. At the end of the code ring the inner spring associated with cam CCC passes on to a surface of reduced radius and opens the circuit of relay CC which releases and connects earth over relay TR to the a wire and battery over wiper 7 to the b wire.

When the subscriber answers the call, relay TR operates in the interval between the end of a code and its re-commencement and effects switching through of the connection as for a local call. Release of relay P opens the circuit of relay CC and when the recording switch RS is released relay R releases and at contact r^4 closes the homing circuit of switch DP. Magnet DFM operates and interrupting its own circuit at contact dpm steps the switch to normal.

If a subscriber wishes to speak to another connected to the same line, he lifts his receiver and awaits dialling signal as in the case of a call through the exchange. On receipt of the dialling signal, the dials a single special digit, to denote that an interparty call is about to be made after which, with the receiver still off the hook, he operates the hand generator to call by means of a code the party required.

In the operator circuit shaft contact h/h of switch RS is arranged to be operated when the switch is stepped to the level corresponding to the special number assigned to interparty calls. The operated contacts prepare a circuit for a relay RL which is operated on the release of the dialling relay D and brings about the release of the operator and connecting circuits and the application of the

busy marking to the subscriber's line in the multiple.

When the special digit is dialled the wipers of switch RS are brought to rest opposite the level assigned to interparty calls and contact *kk* is operated. On the subsequent release of relay D relay RL operates over contacts *d*⁰ and *kk* and locks up over contact *r*¹¹ in parallel with contact *d*².

Contact *r*¹² opens the holding circuit of relay 9 and this relay releases releasing relay A at contacts *b*² and *b*³. Contact *a*¹ falling back opens the circuit of relay V which releases after a brief interval and at contact *v*² opens a further point in the holding circuit of relay B. Contact *v*³ closes the circuit of the release magnet ZM which operates and returns switch RS to normal, the magnet circuit being opened by the restoration of the vertical off-normal contact *kk*⁴.

When relay RL operated, contact *r*¹³ connected battery over a resistance, back contacts *t*³, *p*³, wiper 5 on the second contacts of the set associated with a connecting circuit, wire 5³, wiper M¹, wire *m* winding *l* of relay 10 to earth. Relay LO operates and locks up dependent on relay AV which is held by relay AA connected to the subscriber's line and at contact *lo*² connects earth to wire *c* to mark the line engaged in the multiple and to hold relay OO after the disconnection of the earth on wiper C¹ by contact *tc*² consequent on the release of relay TC at contact *v*¹.

Relay RL is released by the opening of contact *kk* when release of switch RS commences.

During an interparty call although the subscriber's line remains in a calling condition and the operator and connecting circuits are freed and the line marked busy in the multiples; yet the alarm circuit is not brought into operation as it would be if the calling condition persisted owing to a line fault or to a receiver being removed and no impulses being dialled.

The operation of the system under line fault conditions will now be outlined.

Each operator circuit is provided with a pair of relays SA and ZA operable over a slowly rotating cam SZ. The cam after connecting earth momentarily over the right hand contact continues to rotate and after the elapse of a predetermined interval connects earth momentarily over the left hand contact. After further rotation earth is again connected over the right hand contact and another cycle of operations is commenced. The interval between successive applications of earth over the right and left hand contacts is sufficient to cover the normal period during which an operator is in use on a call. Should this period be exceeded, as for instance, by a subscriber failing to dial within a reasonable time or by the line relay being

operated due to a fault, the operator circuit is released.

When an operator circuit is taken into use relays B, A and V (Fig. 4) operate. Contact *v*³ connects relay SA to the right hand contact operated by cam SZ and when earth is connected over this contact by the cam, the relay operates, locks up over contact *sa*¹ and prepares a circuit for relay ZA over contact *sa*². If, by the time earth is connected to the left hand cam contact, the operator circuit has not been released relay A operates and locks up over contacts *sa*² and *za*¹. Contact *za*² opens and releases relay B which in turn releases relays A and V and the operator circuit is released from the calling line, relays SA and ZA releasing. Relay TC is released and earth is disconnected from wiper C¹ and relay CO in the line circuit releases. Relay AA being still operated relay L re-operates over a loop circuit closed by contact *aa*² and relay PG (Fig. 2) remains held and the alarm relay PL is operated. The line is marked unavailable to a connector by the absence of battery potential on the test bank contact.

What I claim is:—

1. In a telephone system, a plurality of party lines, a dial at each party line station, exchange apparatus common to said lines and seized upon the initiation of any call, means responsive to the dialling of a predetermined digit by a calling subscriber for disconnecting his line from said common apparatus and for marking the line busy, and means at the calling station for signalling another party on the same line.

2. In a telephone system, party lines, automatic switching apparatus seized responsive to a call on one of said lines, a dial at the calling station for controlling said apparatus to connect with another line, means for disconnecting said apparatus from the calling line responsive to the dialling of a predetermined digit in case the calling subscriber desires to call another party on the same line, and means at said calling station for signalling the desired station on the same line independent of said switching apparatus.

3. In a telephone system, a plurality of lines, automatic switching apparatus for use in connecting said lines, means responsive to a call on a line for seizing said apparatus, means for releasing said apparatus operative automatically if the calling subscriber dials a predetermined digit, and means for releasing said apparatus operative automatically if he fails to dial any digit within a predetermined time.

4. In a telephone system, a plurality of lines, automatic switching apparatus for use in connecting said lines, means responsive to a call on a line for seizing said apparatus, means for releasing said apparatus if the calling subscriber dials a predetermined digit

- or if he fails to dial any digit within a predetermined time, an alarm, and means for operating said alarm in case the said apparatus is released because of failure to dial but not in case of release responsive to a predetermined digit. 70
5. In a telephone system, a plurality of lines, automatic switching apparatus common to said lines, means for connecting a line to certain of said apparatus responsive to a call or to an abnormal condition on the line, timing means rendered effective when the line is connected, means controlled by said timing means for disconnecting the line from said apparatus in case the line is in abnormal condition, and means individual to the line for maintaining the line disconnected from said apparatus and for giving an alarm. 75
6. In a telephone system, a plurality of party lines, a dial at each party line station, line equipment individual to each of said lines, automatic switching apparatus common to said lines and seized by one of said lines when the line assumes a calling condition, means responsive to the dialling of a predetermined digit by a calling subscriber for releasing said apparatus and for returning a signal to said line equipment and means in said line equipment responsive to said signal for preventing further seizure of said apparatus and for marking the line busy to incoming calls. 80
7. In a telephone system, a plurality of party lines, a dial at each party line station, automatic switching apparatus common to said lines and seized by one of said lines when the line assumes a calling condition, line equipment individual to said line and including a line relay and a cut-off relay, means for releasing said apparatus provided dialling impulses are not received within a predetermined period, means responsive to the release of the common apparatus for releasing said cut-off relay and operating said line relay to close an alarm circuit, means responsive to the dialling of a predetermined digit for releasing said apparatus and returning a signal to said line equipment, and means responsive to said signal for preventing the release of said cut-off relay and the closure of said alarm circuit. 85
8. In a telephone system, a plurality of party lines, a dial at each party line station, automatic switching apparatus common to said lines and seized by one of said lines when the line assumes a calling condition, line equipment including a cut-off relay individual to said line, means for releasing said apparatus if dialling impulses are not received within a predetermined period, means responsive to such release of said apparatus for releasing said cut-off relay to close an alarm circuit, means responsive to the dialling of a predetermined digit for releasing said apparatus and returning a signal to said line equipment, and a relay operated by said signal to prevent the release of said cut-off relay and the closure of said alarm circuit. 90
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