

Feb. 14, 1939.

C. E. BEALE ET AL

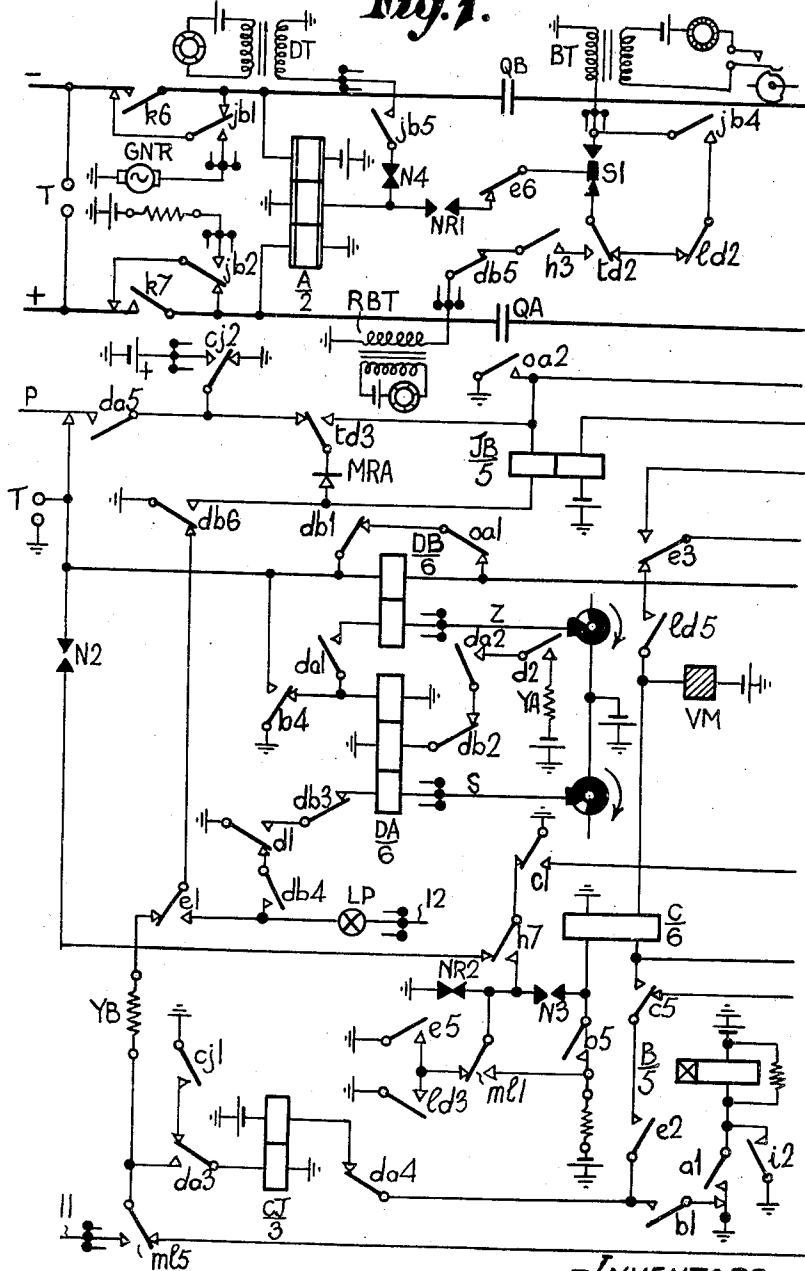
2,147,235

TELEPHONE SYSTEM

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2 Sheets-Sheet 1

Fig. 1.



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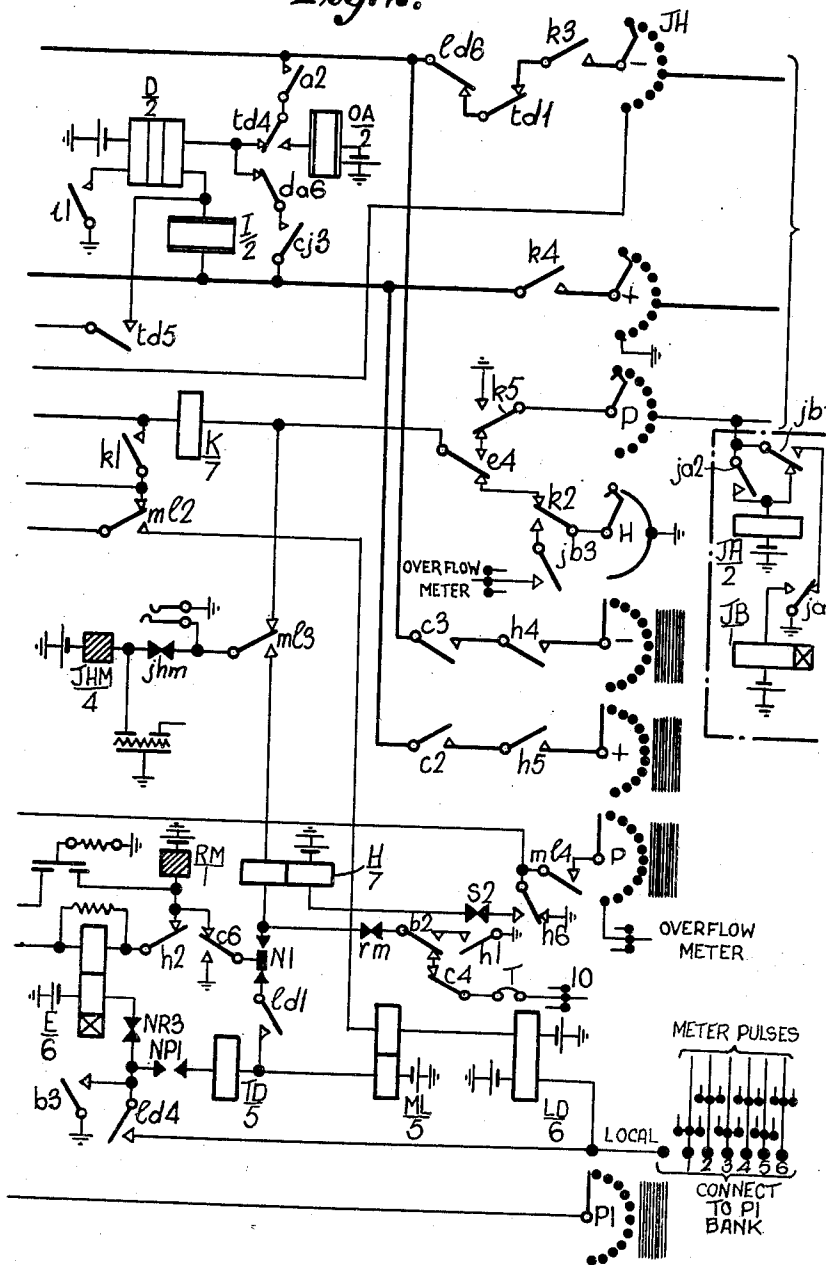
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2 Sheets-Sheet 2

Fig. 2.



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TELEPHONE SYSTEM

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8 Claims. (Cl. 179—27)

The present invention relates to telephone systems and is more particularly concerned with systems including so-called satellite exchanges having their first numerical switches in an associated main exchange. It is the chief object of the invention to provide an improved discriminating selector repeater for use in satellite exchanges with special arrangements for giving the necessary tones and for simplifying the provision of multi-metering facilities.

According to one feature of the invention in a telephone system including satellite exchanges the switches used at a satellite exchange for discriminating between local and main exchange calls and for completing local calls also have direct access over their wipers to an operator's position in a distant exchange.

According to another feature of the invention in a telephone system including satellite exchanges the switches used at a satellite exchange for discriminating between local and main exchange calls and for completing local calls are arranged to extend connections over their wipers after having responded to a plurality of digits and restored to normal and also after having responded to a single digit only.

A further feature of the invention is that in a telephone system including satellite exchanges the switches used at a satellite exchange for discriminating between local and main exchange calls and for completing local calls are provided with equipment responsive to distinctive signals from an operator's position whereby the release of the switch may be prevented and the calling party re-rung.

The invention will be better understood from the following description of one method of carrying it into effect, reference being had to the accompanying drawings comprising Figs. 1 and 2 which show the circuits of a discriminating selector repeater switch of the two-directional type arranged to have so-called rectangular motion. This switch is located at the satellite exchange and has associated with it a so-called unselector which serves to select a free junction line to the main exchange. The discriminating selector switch may be of the mechanical construction disclosed in Saxby's Patent No. 2,028,689.

Considering now the setting up of a call, when the switch is taken into use, for instance over a finder switch, the satellite subscriber's loop placed across the incoming negative and positive conductors operates relay A over its upper and lower windings in series. This relay upon operating at armature *a1* energizes relay B which thereupon

at armature *b4* guards the switch by applying earth to the release trunk conductor P while armatures *b5* and *b3* operate relays C and E to prepare a circuit for the vertical magnet VM. Armature *e1* completes a circuit to light the switch supervisory lamp LP by way of common equipment connected to conductor 12 which is arranged to give an alarm if the lamp is lit longer than a predetermined period while armature *e4* connects the junction hunter magnet JHM to the junction hunter test wiper P and armature *e3* connects the earthed winding of relay K on to the same wiper. If the outgoing junction on which the junction hunter wipers are standing is already engaged, earth will be encountered by the P wiper and will serve to energize the magnet JHM while at the same time relay K will be short-circuited. On operation of the magnet the interrupter springs *jhm* open and disconnect the magnet energizing circuit and the magnet thereupon releases. Since the switch is of the reverse drive type the wipers are stepped forward on release of the magnet to the next position and if the P wiper again encounters an earth the wipers will be again stepped. The self-interrupted driving action will continue until a free junction to the main exchange is found when no earth will be encountered to energize the magnet. Relay K will then no longer be short-circuited and will immediately operate in series with the magnet JHM which is non-operative in this condition. Armature *k1* thereupon completes a holding circuit for relay K which is independent of armature *e3*, armature *k5* earths the P wiper to guard the outlet seized and armatures *k3* and *k4* extend a loop by way of armatures *td1*, *ld6*, *a2*, *td4* and the windings of relays D and I in series across the junction thus energizing the distant exchange equipment which returns dial tone to the calling subscriber. Relay I operates in this circuit but has no function at this stage of the call while the current flow in the two windings of the shunt field relay D is in such a direction as to prevent its operation.

In case all the outgoing junctions should prove busy the junction hunter switch will rotate to the last position. This position is not multiplied to other switches and since no earth can be encountered thereon by the P wiper relay K will be operated in series with the magnet whether there are any other switches standing in this position or not. A circuit is now completed from earth by way of the positive junction hunter wiper, armature *k4*, windings of relays I and D in series, armatures *td4*, *a2*, *ld6*, *td1*, *k3* and the negative

wiper to operate relay JB over its right-hand winding. Relay JB upon operating completes a circuit by way of the dial tone transformer DT and the middle winding of relay A to transmit dial tone by induction to the calling subscriber. This arrangement gives the possibility of completing local calls over the local train of switches even though no junction is available to the main exchange.

The subscriber now dials the first digit and relay A de-energizes intermittently. Each time relay A releases a circuit is completed by way of armatures *a1*, *b1*, *e2*, *c5*, right-hand low resistance winding of relay C to battery via the vertical magnet VM and the switch will thereupon be stepped to the required level. Relay B is slugged in the usual manner to enable it to hold during each pulse train. The off-normal springs are operated immediately the switch steps off normal and springs N3 short-circuit the left-hand winding of relay C to enable this relay also to remain operated during the impulse train while springs N4 disconnect the dial tone. Relay CJ is operated on the first release of relay A and at armature *cj1* short-circuits its lower winding to enable it to hold operated throughout the train. At the end of the first impulse train relay A remains operated and after a short interval relay C releases and armature *c5* transfers the impulse circuit to the rotary magnet RM.

When the second series of impulses is received the rotary magnet RM is energized in series with the upper low resistance winding of relay E and serves to advance the wipers to the desired set of contacts in the level chosen. The rotary off normal springs are operated on the first rotary step and springs NR3 disconnect the lower winding of relay E which however due to its slug will hold over its upper winding during the pulse train. It will be understood that both the foregoing trains of pulses will also be repeated over the junction to the main exchange by means of armature *a2* which is bridged across the outgoing negative and positive conductors. The operation of relay CJ during each pulse train at armature *cj3* short-circuits relays D and I to give an impedance-free impulse loop to the main exchange.

Assuming first that the local exchange digits have been dialled, the P1 wiper of the discriminating selector will come to rest on a bank contact which is connected by way of the "local" terminal to the lower winding of relay LD. When relay E restores at the end of the second digit, a circuit will be completed from earth, armatures *db6* and *e1*, resistance YB, armature *m15* and wiper P1 to operate relay LD which at armature *ld4* thereupon locks to earth by way of armature *b3*. The junction circuit is thereupon opened at armature *ld6* to release the main exchange equipment while at armature *ld5* a circuit is completed to re-energize the vertical magnet from earth by way of armatures *b4*, *db1*, *oa1*, *m12* and *e3*. The vertical magnet pawl when operated is arranged to engage with an extension arm of the rotary detent and move it out of engagement with the rotary ratchet member to initiate the full release of the switch along the path over which it has been set, for instance in the manner described in the specification previously mentioned. When the switch reaches the normal position, the off-normal springs and the rotary off-normal springs will be restored to the normal condition and relays C and E will be operated again in preparation for reception of another digit. Relay LD remains operated and on the

re-operation of relay C a circuit is completed from earth, armature *c6*, springs N1 and armature *ld1* to operate relay ML by way of its lower winding. Relay ML thereupon locks over its upper winding in series with the upper winding of relay LD and releases relay K at armature *m12*; connects up the single fee meter pulse lead 11 at armature *m15* and also at armature *m13* prepares a circuit for relay H in order to allow the switch to function as a group selector.

The subscriber now dials the third digit of the local number and the switch shaft and wipers are raised to the corresponding level. On the first vertical step the off-normal springs again operate and since relay C holds operated during the pulse train, relay H will be operated from earth, armature *c6*, springs N1, left-hand winding of relay H, armature *m13* to battery via the magnet JHM. Thereupon at armature *h1* a locking circuit is completed for relay H by way of the rotary magnet interrupter springs *rm*.

At the end of the impulse train relay C releases after its slow period and at armature *c6* completes a self-interrupted driving circuit for the rotary magnet RM from earth, armatures *h1* and *b2*, interrupter springs *rm*, springs N1, armature *c6* and magnet RM to battery. On the first energization of the magnet the wipers will be advanced on to the first set of bank contacts in the level chosen while the interrupter springs *rm* will be opened. If this set is busy, the earth encountered by the P wiper will be extended via armatures *m14* and *h6* and cam springs S2 to hold relay H over its right-hand winding. The rotary magnet will therefore drive the switch in a self-interrupted circuit until the test wiper P fails to encounter a contact with either an earth potential indicating a busy condition or a booster battery potential in case metering is taking place, whereupon relay H will release quickly and at armature *h1* open the magnet driving circuit. On the release of relay H, the earth short-circuiting the left-hand winding of relay C by way of springs N3, armatures *h7* and *c1* is removed and relay C now re-operates. Armature *c6* thereupon completes a circuit to re-operate relay H over its left-hand winding in series with the magnet JHM, while armature *c1* extends a guard earth on to the P wiper by way of armature *m14* to replace that which will be removed at armature *h6*. Armatures *c2*, *c3*, *h4* and *h5* extend the D and I repeat impulse loop by way of the negative and positive wipers through to the succeeding switch and the discriminating selector switch will act as an impulse repeater for the remaining digits of the number.

Subsequent dialling will result in further automatic switches being set up to establish connection with the called local subscriber who will then be rung in the usual manner. Upon his reply the ringing will be tripped and battery will be reversed from the final selector to operate the shunt field relay D which at armature *d1* completes the starting circuit for the meter delay set. This latter piece of apparatus comprises the relays DA and DB which are operated by a so-called S and Z pulse cam which is arranged to supply battery pulses with a definite time relation to two corresponding leads. Upon the transmission of the next S pulse, relay DA will be operated over its lower winding and will prepare a circuit for relay DB which operates after the appropriate time interval from the Z pulse in series with the upper winding of relay DA. Relay DA remains locked over its middle winding

in series with resistance YA until the relay DB operates from the Z pulse when both the initial energizing circuit and the locking circuit for relay DA are opened but this relay remains held on its upper winding in series with the lower winding of relay DB for the duration of the Z pulse. During the application of the Z pulse the single fee metering lead 11 is extended by way of armatures *m15* and *da3* to the lower winding of relay CJ which thus receives a single metering impulse and at armature *cf2* transmits a pulse of booster battery over the release trunk conductor P to operate the subscriber's meter in the usual manner. At the end of the Z pulse, relay DA restores to prevent any further operation of the metering relay CJ while relay DB remains operated from earth on the release trunk conductor in series with the upper windings of relays ML and LD since its upper winding is no longer short-circuited at armature *db1*. It will be seen that relay CJ combines the functions of a relay energized throughout a train of impulses and of a relay responding to meter pulses.

If the discriminating selector repeater fails to find a free outlet to a succeeding local switch, the wipers are rotated to the 11th position where the cam springs are operated. Springs S2 open the holding circuit for relay H which then releases and opens the rotary magnet driving circuit and at armature *h6* applies earth to the P wiper to operate an overflow meter. At springs S1 a circuit is completed from the busy tone transformer BT to transmit busy tone to the calling subscriber by induction from the middle winding of relay A to inform him that the connection cannot be completed.

Considering now a call to the main exchange, the circuit operation is the same as above described up to the end of the second digit when relay E restores, whereupon in case the junction finder has been unable to locate a free junction, busy tone will now be returned to the calling party by way of armatures *jb4*, *ld2* and *td2*, cam springs S1, armature *e6*, rotary off normal springs NR1 and the middle winding of relay A.

Assuming however that a free junction has been located, the first two digits will have been repeated to the switches in the main exchange and the wipers of the discriminating selector repeater will be standing in a position corresponding to these digits. Further trains of impulses will not affect the setting of the discriminating selector repeater which now acts as an ordinary impulse repeater. The P1 contacts corresponding to exchanges having the same zone fee are multiplied together and connected to the appropriate meter pulse common lead. For example in the position corresponding to an exchange requiring a fee of two units the P1 contact will be wired to the double metering common. Upon the battery reversal taking place when the called party replies, relay D will be operated as before to connect up the meter delay set which functions as previously described and relay CJ will now be operated twice over its lower winding by way of the double fee meter pulse common, connection to P1 bank contact and wiper, armatures *m15* and *da3* and the lower winding of relay CJ. Armature *cf2* will thereupon apply booster battery to the release trunk conductor to register the number of units on the subscriber's meter.

Subscribers wishing to call the manual operator are instructed to dial the digit "0" in response to which the discriminating selector repeater will be stepped up to the 10th level whereupon the

normal post springs NP1 will be operated and complete a circuit for relays TD and ML in series. It is assumed that the services of the operator are chiefly required for a demand trunk call and in order to prevent degradation of transmission it is arranged that there are a number of high grade junctions to the main exchange extending from the 10th level of the switch. Armature *td1* opens the ordinary junction circuit to release the normal train of switches, armature *td4* connects the operator control relay OA on to the negative line while armatures *td3* and *td5* connect relay JB to the positive line by way of the winding of relay I in preparation for re-ringing the calling subscriber if necessary. Relay ML operates relay H as previously described while armature *m12* completes a circuit to operate relay LD in series with the upper winding of relay ML. At the end of the impulse train, relay C releases after its slow period and completes a self-interrupted circuit for the rotary magnet RM, the switch now acting as a group selector. When a free junction is found relay H releases and opens the driving circuit and also re-operates relay C. Relay C thereupon reenergizes relay H and the subscriber's loop is now extended over the high grade junction to the manual board. Moreover at armature *h3* a circuit is completed for transmitting ring-back tone to the calling subscriber by way of the winding of the transformer RBT, armatures *db5*, *h3* and *td2*, cam springs S1, armature *e6*, springs NR1 and the middle winding of relay A. When the operator plugs into the junction line, earth will be extended over the negative line to operate relay OA which at armature *oa1* removes the short-circuit from the upper winding of relay DB which then operates and at armature *db5* disconnects the ring back tone.

Should the operator be unable to complete the trunk call on demand she may take down details of the call and the subscriber may replace his receiver. Relay A will thereupon release and open the circuit of relay OA which at armature *oa2* removes the short-circuit from the left-hand winding of relay JB. Relay I is now held in a circuit from earth by way of armature *db6*, metal rectifier MRA in a conductive direction, armatures *td3* and *td5* and relay I to battery on the positive line extending to the operator, relay JB being nonoperative at this time due to the low resistance of the rectifier. Armature *i2* will thereupon hold relay B thus giving the operator control of the release of the switch. When the operator is able to complete the trunk call she may re-ring the calling subscriber by applying booster battery to the positive line thus operating relay JB by way of its left-hand winding. Armatures *jb1* and *jb2* extend ringing current from the generator GNR by way of normal armatures *k6* and *k7* to the incoming positive and negative conductors thereby ringing the calling subscriber.

When the calling subscriber restores his receiver at the end of the conversation assuming in the case of manual calls that the operator has also released, relay A releases and releases relay B. Relay B releases any other relays which are operated and a self-interrupted circuit is completed for the rotary magnet from earth extended on to common lead 10 by way of equipment which is arranged to give a delayed alarm in case of failure to release, test link T, armatures *c4* and *b2*, interrupter springs *rm*, off-normal springs N1, armature *c6* to battery via the magnet. Accordingly the switch wipers are rotated clear of the

banks after which they fall and then rotate below the banks under spring tension to their normal position where the off-normal springs open and disconnect the homing circuit. Preferably the rotary magnet is mechanically prevented from opening its interrupter contacts during the release movement so that there is no tendency for it to chatter. At the same time a homing circuit is completed for the junction hunter uniselector from earth by way of the homing bank and wiper H, armatures *k2*, *e4* and *m13*, interrupter springs *jhm* to battery via the magnet JHM and all equipment is thus restored to normal.

At the commencement of release an initial unguard is provided on the release trunk conductor P in order to allow preceding switches to restore, this period being represented on local calls by the sum of the release times of relays ML, C and H on junction calls by the release time of relay C. On local calls on the release of relay B the guard earth is removed from the release trunk conductor at armature *b4* and at the same time relay ML will commence to release. When relay ML falls away it opens the circuit of relay C at armature *m11* and it releases slowly due to its short-circuited upper winding and on the release of relay C the holding circuit of relay H is opened at armature *c1*. When relay H releases earth is again applied to the release trunk conductor by way of armatures *c1*, *h1* and the springs N2 until the switch completely restores to normal. On junction calls it will be seen that the unguard period provided will be represented by the release time of relay C only since relays ML and H are not operated.

In order to provide the necessary guard on release of the junction extending to the main exchange, relays JA and JB are provided for each junction circuit and the conditions of release are such that on normal junction calls relays B, K, JA and JB have to release in succession before the junction is freed while in the main exchange incoming switch only two slow relays release to free the switch. This arrangement therefore ensures a guarding overlap to prevent the main exchange switches being taken into use before they are fully released.

It will be seen that according to the invention the functions of a discriminating selector repeater and of a trunk demand relay set are combined and that this permits relay JB to serve as a re-ring circuit and also as a dial tone connecting relay while relay DB used during metering is arranged to cooperate with relay OA to give the operator hold when the trunk exchange answers.

We claim:

1. A telephone system including a main and a sub-exchange and having switching selector repeaters in the sub-exchange having access to local subscribers through their wipers and an auxiliary switch individual thereto and operated independently of said wipers for extending connections to the main exchange, said selector repeater being released after each second digit when a call is extended to a local subscriber over the wipers, together with means in the selector repeater responsive to a particular first digit for extending a connection over said wipers without releasing them.

2. In a telephone system, a switching selector

repeater having wipers and an auxiliary switch individual thereto and operated independently of said wipers, and repeater responsive to a particular first digit to automatically select an idle trunk and extend a connection thereover before the wipers are released, said repeater also responsive to particular first and second digits to operate the wipers and then release and re-operate them to connect with a local subscriber, said repeater also responsive to other first and second digits to hold the wipers operated but ineffective and complete a connection to the main exchange over the auxiliary switch.

3. In a telephone system, a switching selector repeater as claimed in claim 1 having means responsive to a signal from the operator when a connection is extended to her position to re-ring a calling subscriber and prevent the release of the switching selector repeater.

4. In a telephone system, main and sub-exchanges, a selector repeater in the sub-exchange having wipers and an auxiliary switch individual thereto and operated independently of said wipers, said repeater having access through its wipers to local subscribers and also to trunk lines extending to the main exchange, said repeater also having access through the auxiliary switch to other trunk lines extending to the main exchange.

5. A telephone system as claimed in claim 4, in which certain of said trunk lines terminate in an operator's position direct, while another group of said trunk lines terminate in automatic switches.

6. A telephone system as claimed in claim 4, in which said selector repeater is provided with means for transmitting dial tone to a calling subscriber when all trunks accessible to said auxiliary switch are busy and for enabling a calling subscriber to control said selector repeater to extend a connection to a local subscriber.

7. In a telephone system, a selector repeater as claimed in claim 1 having a relay operated responsive to an all trunks busy condition of said auxiliary switch to transmit dial tone to a calling subscriber, said relay also adapted to be energized by a signal from the operator when a connection is extended to her position to re-ring a calling subscriber.

8. In an automatic substation associated with a plurality of trunks, a control line, a switching selector repeater having wipers and an auxiliary switch each associated with said control line for extending a direct connection therefrom to a selected one of said trunks, said auxiliary switch operating responsive to the seizure of the repeater to select an idle one of said trunks, means for transmitting digits over said control line, said selector repeater operating responsive to a particular first digit to automatically select another idle one of said trunks, a relay in the selector repeater, means for maintaining said relay operated responsive to said digits to improve the transmission thereof over an extended connection and means for operating said relay when a connection is completed to transmit signals thereover.

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