

M. S. CONNER.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED JAN. 23, 1907.

901,689.

Patented Oct. 20, 1908.
2 SHEETS—SHEET 1.

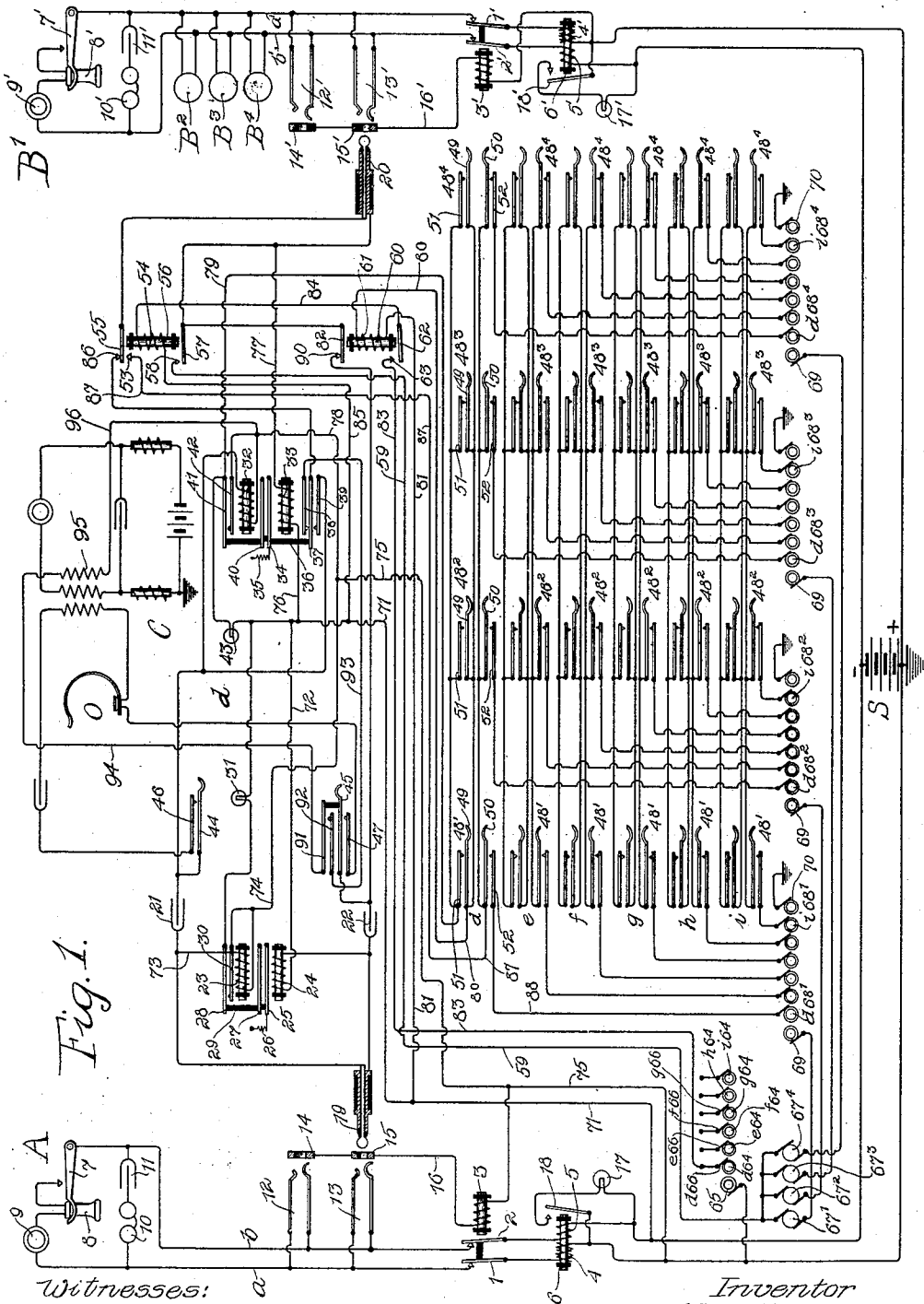


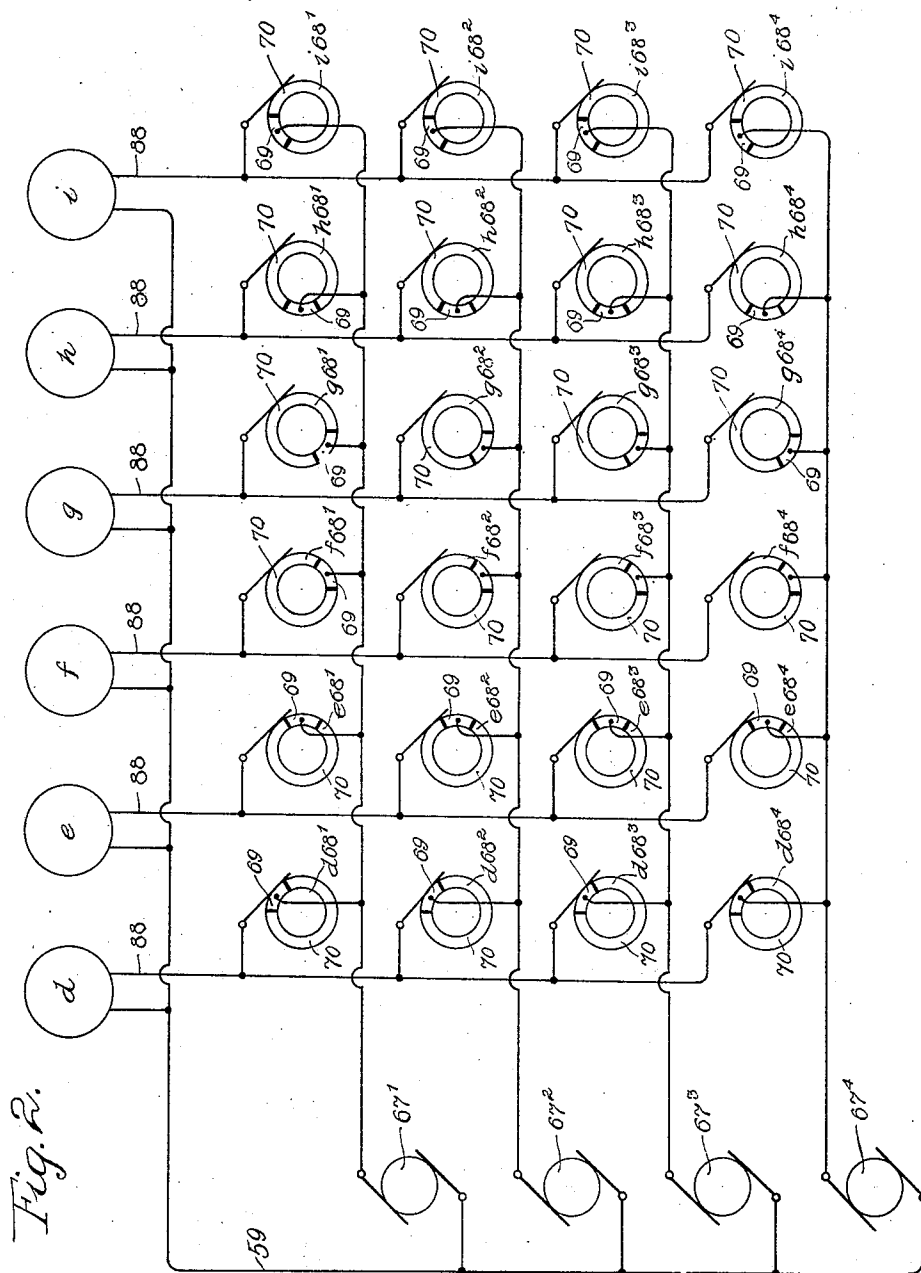
Fig. 1.

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2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, MERRITT S. CONNER, citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented a certain new and useful Improvement in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to telephone exchange systems, more particularly to improved automatic selective ringing arrangements therein, and its object is to provide an exchange system with a ringing equipment which may be maintained at a minimum expense, and which is of greater reliability and efficiency than ringing arrangements of the prior art.

Broadly the invention provides a ringing arrangement, wherein the ringing current source, which may be of considerably less power than those which were employed in ringing equipments of the prior art, is kept constantly loaded so that instead of employing a ringing current generator of great power as in prior systems, where at one period a large demand might be made upon the machine, and at another no demand be made thereon, a generator of smaller power is employed and is so arranged that there is constantly a steady load thereon, whereby the various advantages herein pointed out are secured.

This invention may be considered as an improvement over, and is particularly adaptable in connection with such telephone systems as disclosed in the copending application of Arthur R. Kahl, Serial No. 298,741, filed January 31, 1906. On the system disclosed in this Kahl application, means are provided whereby any one of the signaling current generators, which differ from each other in pulsations per second, could be connected with the telephone line. In this system however the ringing equipment was such that there might be a very large number of substation bells simultaneously in operation, and another time there might be a very small or practically no demand upon the ringing current generator. In order therefore to maintain the proper operation of such a system, the ringing current generators employed were necessarily of large

power, so that they would be able to meet the large demand which might be placed upon them. The present invention however eliminates this necessity, and provides means whereby a limited number of bells may be rung simultaneously, all the other bells connected with the exchange at that time remaining inert. Thus the bell of the subscriber who is being signaled would be active for a definite period, and would remain active while the bells of certain other subscribers being signaled are active. To this end the circuits are arranged in groups, which for convenience in this description may be termed ringing divisions, each division being provided with its own selective keys and interrupters.

Means are provided in this invention whereby several ringing divisions are brought into such relation with each other, that ringing current will be supplied to one ringing division at a time; that is, the ringing period of one division follows that of another division and is immediately succeeded by the ringing period of another division. The signal current is thus fed to the circuit divisions in regular consecutive order, the maximum demand at any one time being that made by all the circuits in a single division. The maximum demand at any one time is thereby greatly reduced and generators of smaller power may therefore, be employed.

These various improved relations and arrangements of my invention whereby an efficient power automatic selective signaling system is obtained, will be best understood by reference to the accompanying drawings in which

Figure 1 diagrammatically illustrates a system arranged according to my invention, and Fig. 2 illustrates diagrammatically the arrangement whereby the different signaling currents are supplied to the circuits, the collateral apparatus, however, being omitted for the purpose of clearness.

In Fig. 1 I have illustrated a sub-station A connected by line limbs *a* and *b* with the central exchange C, these line limbs being continuous normally through armatures 1 and 2 of the cut-off relay 3 and including the windings 4 and 5 of the indicator relay 6, connecting them with the terminals of the common source of current S. At the sub-station is provided the usual telephonic ap-

paratus comprising a switchhook 7, receiver 8, transmitter 9, signal bells 10, and condenser 11. The multiple spring jacks 12 and 13 are connected in bridge of the line limbs, and the test thimbles 14 and 15 thereof are connected together by conductor 16 which includes the cut-off relay 3 and terminates at the positive pole of the battery S. A line signal 17 is included in a local circuit controlled by the armature 18 of the indicator relay 6. A sub-station B¹ is provided with similar apparatus as sub-station A and connects through the line limbs with the central exchange C, the cut-off relay mechanism and connections therefor, being the same as those connected with the sub-station A. The reference characters of the sub-station B¹ telephone apparatus, line and central station apparatus are, however, primed. This line is shown as a party line, and besides the sub-station B¹ are indicated the sub-stations B², B³ and B⁴.

The cord circuit at the central exchange terminates in the answering plug 19 and the calling plug 20. Condensers 21 and 22 are included in the strands of the cord circuit respectively to prevent their conductivity between the answering and calling sides thereof. The supervisory relay for the answering side is of the compound type, comprising windings 23 and 24. The armature 25 for the winding 24 is mechanically connected with the spring 26 which tends to hold this armature in its unattracted position. Armature 27 is provided for the winding 23 and is mechanically connected with the actuating spring 28 by means of the insulating piece 29. Armature 25 is adapted to mechanically engage the armature 27, and the actuating spring 28 has associated therewith a contact spring 30 from which it is normally disengaged, but which it is adapted to engage when the winding 24 is energized whereby the armature 25 is attracted against the tension of the spring 26, thus allowing the armature 27 to drop, and causing the actuating spring 28 to engage the contact spring 30. The contact springs 28 and 30 control a circuit containing the supervisory lamp 31 and the source of current. The supervisory relay for the calling side comprises the windings 32 and 33. The armature 34 for the winding 33 is mechanically connected with the spring 35 which tends to hold it in its unattracted position. Mechanically connected with the armature 34 by means of the insulating piece 36 is the actuating spring 37 which has the alternate contacts 38 and 39, the purpose of which will be hereinafter pointed out. The armature 34 by reason of the tension of the spring 35 is adapted to engage the armature 40 for the winding 32 whereby the actuating spring 41 by reason of its mechanical engagement with the armature 40 may be held normally out of engagement with the contact

spring 42. The actuating spring 41, however, is adapted to engage the contact spring 42 when the winding 33 is energized to attract the armature 34 against the tension of the spring 35, thus allowing the armature 40 to drop and the actuating spring 41 to engage the contact spring 42. When the winding 33 is thus energized, the actuating spring 37 is adapted to engage the spring 39, and when it is not energized, the actuating spring 37 engages the contact spring 38 by reason of the tension of the spring 35. The contacts 41 and 42 control a local circuit through the supervisory lamp 43 for the calling side and the common source of current.

The connection with the line of the operator's telephonic apparatus O is controlled by the position of the key springs 44 and 45. These key springs 44 and 45 are adapted upon actuation to engage respectively the contact springs 46 and 47 which are directly connected with the operator's telephonic apparatus. For the purpose of facilitating the proper description the operation of these arrangements is explained in regard to a single cord circuit, but as will be hereinafter pointed out, when the ringing arrangements are explained, this cord circuit should be considered as a group of cord circuits which are supplied in parallel with the proper ringing current. While these ringing divisions hereinbefore mentioned may be of any reasonable number, I have for the purpose of illustration shown six divisions, these divisions being designated conveniently as *d*, *e*, *f*, *g*, *h*, and *i* respectively. It must be remembered that each of the divisions comprises a group of cord circuits, the number of such groups determining, according to this invention as will be hereinafter described, the relative lengths of the active and silent periods of the signaling devices at the substations. For the purposes of illustration and description six groups or divisions are shown. Thus in signaling a subscriber the signaling device would be active one-sixth of the time and silent five-sixths. Each of the groups of cord circuits is provided with selective automatic ringing apparatus including the keys 48¹, 48², 48³, and 48⁴.

In order that the drawings may not be too complicated, I have omitted in Fig. 1 the groups of cord circuits which are connected respectively with the keys 48¹, 48², etc. of the ringing divisions *e*, *f*, *g*, *h*, and *i*, and I will describe the operation of the system of Fig. 1 with reference to the selective keys of group *d* alone. Each of the keys 48¹, 48², 48³, and 48⁴ consists of the actuating springs 49 and 50 and the contact springs 51 and 52 adapted to be engaged by the actuating springs 49 and 50 respectively. The actuating springs 50 of all the keys 48¹, 48², 48³, and 48⁴ are connected together and to the front contact 53 of the relay 54 which con-

tact is adapted to be engaged by the armature 55 when the winding 56 of the relay 54 is energized. The relay 54 is provided also with the contact armature 57 which has the front contact 58, this front contact being connected with one pole of the signaling current generators by means of the conductor 59. The actuating spring 52 which makes the contact with the actuating spring 50 is connected with the other pole of the signaling current generators through the associated interrupting devices, as will be hereinafter described. The armatures 55 and 57 are connected with the strands of the cord circuit, and it will appear evident that when the relay 54 is energized, these armatures will be attracted to cause the signaling current to be bridged across the cord strands.

As will be hereinafter pointed out, each of the keys of the selective apparatus of any cord circuit group is adapted to send current over the line which has different characteristics from any of the currents which are sent over the line by the actuation of any of the other keys of the selective apparatus for that particular group. In order that the current source may be connected with the line until the called subscriber has answered his call, I provide automatic means whereby any particular key when depressed will be retained in such depressed position by means of the energization of a relay, and further means is provided whereby the circuit through this locking relay is controlled by the position of the switchhook at the called station. Thus, when the called subscriber removes his receiver from the switchhook, this locking relay is deenergized to cause the release of the selective key, and the signaling current is, therefore automatically disconnected from the line when the subscriber has answered his call. This locking relay is designated at 60 in Fig. 1, and one terminal of its winding 61 is connected with the actuating springs 49, 49, while the other terminal thereof is connected with the negative pole of the battery. The springs 49 are adapted to engage respectively their associated contacts 51 which are connected together and with the spring 41 of the supervisory relay. The contact 42 associated with the spring 41, as before stated, is connected with the positive pole of the battery. The relay 60, therefore, is adapted to be energized upon contact between springs 49 and 51 and simultaneous contact of springs 41 and 42. Means are provided whereby contacts 41 and 42 are closed together upon the insertion of the calling plug in the jack, and the depression of any selective key when the calling plug is in the jack will cause contact between the springs 49 and 51 and will thereby close the circuit through the relay 60 to energize the same, thus locking the depressed key in position. Means are also provided

whereby the springs 41 and 42 are parted upon the removal of the receiver from the hook at the called sub-station, and the circuit through the relay 60 is thus broken to deenergize the same and allow the selective key to return to its normal position.

The mechanical arrangements and the precise construction of the selective apparatus are shown in detail in the co-pending application of Kahl referred to, and I, therefore, here simply describe the operation of this key mechanism with reference to the diagram in a general way, as it will appear evident that any kind of electromagnetic locking and releasing means may be employed.

It appears evident that the signaling current can be supplied to the line only when the relay 54 is energized, and as will appear evident from the foregoing, signaling current should be sent over the line only when the relay 60 is energized. I, therefore, provide an armature 62 which has the front contact 63 and which primarily controls the circuit through the relay 54. This circuit through the relay 54 is secondarily controlled by means of the interrupter d^{64} . The constant contact 65 of this interrupter is connected to the positive pole of the battery, and the brush contacts d^{66} , e^{66} , f^{66} , etc. are connected respectively with the similar relays of their associated cord circuit groups. Thus, the brush contact d^{66} is connected to all the relays 54 in group d . The interrupter d^{64} , therefore, controls the relay 54 after the relay 60 has been energized. The active period of the interrupter e^{64} begins immediately upon the close of the active period of the interrupter d^{64} , and the active period of the interrupter f^{64} begins immediately upon the cessation of the active period of the interrupter e^{64} , etc. Since, as in the present instance, there are six interrupters, one for each cord circuit group, there are six ringing periods of equal duration to take place, each immediately after the cessation of the preceding one. Therefore, the complete cycle represented by the sum of the ringing periods of all the different divisions would be represented by one revolution of one interrupter. Thus, the relays 54 of group e may become energized immediately after the relays 54 of group d have become deenergized.

The ringing circuit which is bridged across the cord strands whereby the current may be sent over the lines includes the current generator 67 which is one of the set 67^1 , 67^2 , 67^3 , and 67^4 , the interrupter 68 which is one of the interrupters d^{68} , e^{68} , f^{68} , g^{68} , etc., and one of the pairs of springs 50 and 52 of either the keys 48^1 , 48^2 , 48^3 or 48^4 . The interrupters 68 and the interrupters 64 may be mounted on a common shaft. The generators 67 deliver currents which differ from one another in pulsations per second, and

each of the sub-station bells on the telephone line are adapted to respond only to currents from one of said generators. The selective keys 48¹, 48², etc. are, therefore, adapted to
 5 connect any one of the generators 67¹, 67², 67³, etc. with the telephone line whereby a particular signal bell on that line is actuated.

I provide means whereby the current delivered from generator 67¹ is adapted to be
 10 connected with all the selective keys 48¹, and I also provide means whereby this current from the generator 67¹ may be first connected with the key *d*48¹, next with the key
 15 *e*48¹, then with key *f*48¹, etc. Similarly I provide means whereby the current delivered from the generator 67² is adapted to be connected with any of the keys 48², and
 20 also means are provided whereby this current may be fed first to key *d*48², then to key *e*48², then to key *f*48², etc. Similarly the same may be said of the groups 48³ and 48⁴. This arrangement is most clearly shown in Fig. 2 where the ringing means alone have
 25 been diagrammatically shown.

The various groups of cord circuits are indicated at *d*, *e*, *f*, *g*, *h*, and *i*, and there is shown in this figure only the ringing arrangements which are adapted to be bridged
 30 across the cord circuits in the respective groups. The similar poles of the generators 67¹, 67², 67³ and 67⁴ are connected together and are shown as leading to the various groups of cord circuits. The interrupters
 35 are shown as being disposed in groups *d*, *e*, *f*, *g*, *h*, and *i* corresponding with the cord circuits. As shown, the other conductor leading from each group of cord circuits is connected with all the interrupter brush
 40 contacts in the corresponding interrupter group. The interrupters are also arranged in groups 1, 2, 3 and 4. All the constant contacts in group 1 are connected with the other pole of generator 67¹; all the constant
 45 contacts in group 2 are connected with the other pole of generator 67²; all the constant contacts in group 3 are connected with the other pole of generator 67³, and all the constant contacts in group 4 are connected with
 50 the other pole of generator 67⁴. It will be convenient in this description to characterize the reference characters given the parts as to cord circuit groups by the letter indicating the cord circuit group and to give the
 55 reference characters exponents corresponding with the exponents of the generator characters to distinguish them in the generator groups. Each of the interrupters 68 consists of the active portion 69 and the in-
 60 active portion 70, that is, inactive with regard to Fig. 2 where the collateral arrangements are omitted. The function of the portion 70, however, will be explained with reference to Fig. 1.

65 It will be noted that the positions of the

active portions 69 which may be called the ringing segments, are the same in each cord circuit group. Since for the purpose of illustration I have herein shown six groups
 70 of cord circuits, the ringing segment of each group is one-sixth of a revolution in advance of the ringing segment of the succeeding group. These ringing segments are equal, and when the contact brush has left
 75 the ringing segment of the last interrupter, the contact brush of the first interrupter will thereupon immediately engage its ringing segment. When the contact brush has left the ringing segment of the first interrupter, the brush of the second interrupter will en-
 80 gage its ringing segment, and immediately upon leaving its ringing segment, the brush of the third interrupter will engage the ringing segment of the third interrupter, etc. Thus, when the interrupters have made one
 85 complete revolution, the currents from the generators have been delivered to each of the cord circuits, first one, then another, then another, and so on. Of course, it must be remembered that the selective keys are de-
 90 pressed to effectively employ but one generator at a time, that is, when a selective key is depressed, the circuit is closed through the desired current generator and the associated interrupter. Thus, it appears that any one
 95 of the generators may be effectively employed for any of the cord circuit groups, current, however, being adapted to be connected with but one group of cord circuits at any time.

100 Having thus described in general the various arrangements and relations of the mechanisms, I will now proceed to describe the operation of the system with reference to Fig. 1. For the purpose of illustration I
 105 will assume the subscriber at sub-station A to be the calling subscriber. When he removes his receiver from the switchhook, a circuit is closed through the indicating relay 6, thereby attracting its armature 18 to cause
 110 the closure of the local circuit through the line lamp 17. The operator then inserts her answering plug 19 into one of the associated spring jacks connected with the calling line and actuates her listening key to cause con-
 115 tact between the springs 45 and 47 and 44 and 46 respectively. The operator's telephonic apparatus O is thereby connected across the line, and she may converse with the calling subscriber to ascertain the con-
 120 nection desired. Immediately upon the insertion of the calling plug in the line jack, a circuit is closed through the cut-off relay 3 as follows:—from the negative side of the battery, through conductor 71, conductor 72,
 125 winding 24, the sleeve strand of the answering side of the cord circuit, through the plug sleeve contact and jack thimble, conductor 16 and through the cut-off relay winding to the positive side of the battery. The arma- 130

tures 1 and 2 then leave their back contacts, and the winding 24 being also energized, the armature 25 is also attracted against the tension of the spring 26. This would tend to allow the spring 28 to make contact with the spring 30, but these springs are held in a disengaged position by reason of the energization of the winding 23 which is included in a circuit as follows:—from the negative side of the battery S, through conductor 71, conductor 72, winding 24, sleeve strand and sleeve contact of the answering plug, through the spring jack, through line limb *b*, through the telephonic apparatus at the sub-station A, through line limb *a*, through the spring jack to the tip contact and strand of the cord circuit, conductor 73, winding 23, conductor 74, conductor 75 to the positive pole of the battery. Thus, the armature 27 is held in its attracted position whereby the springs 28 and 30 are held disengaged, the local circuit through the signal 31, therefore, being held open. Suppose for the purpose of illustration that the subscriber at sub-station A desires to be connected with the subscriber at sub-station B¹. The operator inserts her calling plug 20 into the spring jack of the line leading to sub-station B¹, thereby closing a circuit through the cut-off relay 3' and the supervisory relay 33 for the calling side of the cord circuit as follows:—from the negative side of battery S, through conductor 71, conductor 76, winding 33, conductor 77, sleeve strand of the calling side of the cord circuit, sleeve contact of the plug, thimble 15', conductor 16', cut-off relay 3' and back to the positive side of the battery. The armatures 1' and 2' are, therefore, attracted to leave their respective back contacts, and winding 33 is energized to attract its armature 34 against the tension of the spring 35. The spring 41 will then be allowed to make contact with the spring 42, since the winding 32 of the armature 40 which controls the spring 41 is not energized. It may be stated in passing that the winding 32 is controlled by the position of the switchhook at the sub-station when the plug is inserted in the jack. The receiver at the sub-station B¹, however, being at this time on its hook, the circuit through the winding 32 is not closed, and this winding remains unenergized. Since the springs 41 and 42 are thus allowed to come into contact, the local circuit through the supervisory lamp 43 is closed as follows:—from the positive side of the battery, through conductor 75, conductor 78, springs 42 and 41, supervisory lamp 43, and conductor 71 to the negative side of the battery. Being thus connected with the line with which the desired subscriber is connected, the operator actuates the selective key which is connected with the source of current to which only that signal bell on the called line which is

at the sub-station of the called subscriber is responsive.

For illustration it may be considered that the key 48¹ is adapted to connect the generator 67¹ to which the signal bells located at sub-station B¹ only are responsive. When the operator, therefore, depresses the selective key 48¹, spring 49 will immediately make contact with spring 51, and a circuit is closed through the locking relay 60 as follows:—from the positive pole of the battery, through conductor 75, conductor 78, contacts 42 and 41, which, as before stated, are now in engagement, conductor 79, spring 51, spring 49, conductor 80, winding 61 of the relay 60, conductor 81, conductor 71, and back to the negative side of the battery. The locking relay 60 is thus energized, and its armature, as before stated, is so mechanically connected with the actuating keys of the associated selective apparatus that upon energization, it locks any key which has been depressed until it is deenergized. The key 48¹ is, therefore, locked in its depressed position. When the relay 60 is thus energized, its armature 82 is attracted to interrupt the sleeve strand of the cord circuit and its armature 62 is attracted to engage the contact 63. This closes a circuit through the relay 54 and the associated interrupters 64 as follows:—from the positive pole of the battery, through interrupter 64, conductor 83, contact 63, armature 62, conductor 84, winding 56, conductor 85 and conductor 71, back to the negative pole of the battery. Thus, during the time that the interrupter 64 closes the circuit just traced, the relay 54 will be energized to attract its armatures 55 and 57. When the armatures 55 and 57 are thus attracted, they engage respectively the front contacts 53 and 58. The armature 55 leaves the back contact to interrupt the tip strand of the cord circuit. The associated current generator for the cord circuit group under consideration is connected between the contacts 53 and 58 through an associated interrupter 68 and a selective key. Thus, upon energization of the relay 54, and since the key 48¹ is depressed at this time, as before stated, a bridge will be closed through the current generator 67¹, the interrupter 68¹ and key 48¹ as follows:—from contact 53, through conductor 87, spring 50, contact 52, conductor 88, interrupter 68¹, current generator 67¹, conductor 59 to contact 58. Therefore, when the relay 54 is energized, the selected current will be sent over the line with which the calling plug has been connected. Since, as before stated, the signal bells at sub-station B¹ only are responsive to current generator 67¹, the subscriber at sub-station B¹ will be the only signaled subscriber on the line. The active segment of the interrupter 64 is so relatively adjusted as to

position with the interrupter $d68^1$ that immediately upon the energization of the relay 54, the bridged circuit through the signaling current generator will be closed. The active segment, however, of the interrupter d^{64} is made slightly longer than the ringing segment of the interrupter d^{68} . The purpose of this construction is as follows:—When the active segment of the interrupter d^{64} connects with conductor 83, the circuit through the relay 54 will be closed, thereby placing the plug cords in the ringing position. Ringing segment 69 of interrupter $d68^1$ will at the same instant connect the ringing current to the line. If these segments were of the same length, when interrupter d^{64} opens the circuit to release relay 54, the ringing current would also be cut off immediately by ringing segment 69. Upon deenergization of relay 54, the tip strand is continued through armature 55 and contact 86, through contacts 37 and 39, winding 32 of the supervisory relay and through conductors 78 and 75 to the positive grounded side of the battery, and as the sleeve side of the cord circuit when connected with the line, has always connection through winding 33 of the supervisory relay and through conductor 71 with the negative side of the battery, the entire charge which the condensers in the telephones and the lines have received will pass through the supervisory winding 32, and as this winding controls the contacts 41 and 42 included in the circuit for relay 60 which in turn controls the circuit through relay 54, the signaling would be seriously interfered with. It is, therefore, necessary to maintain the actuation of relay 60 and relay 54 controlled thereby a sufficient length of time to allow the discharge of the line through the ground connection for the signaling current interrupters, and this is accomplished by making the active segment of the interrupter d^{64} slightly longer than ringing segment 69 of the interrupter $d68^1$. Relay 54 is energized and ringing current at the same time applied to the cord conductors and connected lines. After the corresponding brush leaves the ringing segment of the interrupter $d68^1$, the active segment of the interrupter d^{64} on account of its greater length still engages its brush and maintains closure of the circuit for relay 54 and the charge retained in the condensers and the line is led to ground through the grounded segment 70 of the interrupter $d68^1$. After the corresponding brush leaves the active segment of the interrupter d^{64} , the circuit for relay 54 is opened and the relay deenergized to again complete the tip strand through the winding 32 to ground. The line and other circuits are, therefore, entirely relieved of static charges before and after application of the ringing impulses thereto. It must be understood, of course,

that the foregoing explanation in regard to the relative disposition of the active segments of the interrupters d^{64} and $d68^1$ may be applied to the interrupters 64 and 68 of all the ringing divisions.

The ringing circuit to signal the subscriber may be traced as follows:—from generator 67^1 through interrupter $d68^1$, conductor 88, contact 52, spring 50, conductor 87, contact 53, armature 55, tip strand of the calling side of the cord circuit, tip spring of the spring jack 13', line limb a' , through condenser and signal bells at sub-station B^1 , back to the central station through line limb b' , sleeve spring of the spring jack, sleeve contact of the plug, sleeve strand, armature 57, contact 58, and conductor 59 back to the other pole of the signal current generator 67^1 . When the active segment of the interrupter d^{64} becomes disconnected from conductor 83, relay 54 becomes deenergized, but on account of the arrangement above described, the lines will be free from static charge. The length of such current flow for the relay 54 must evidently be adjusted to correspond to the adjustment of the ringing segments of the corresponding ringing current interrupters which have hereinbefore been described in detail. Upon receiving the signal, the called subscriber removes his receiver from the switchhook, thereby closing a circuit through winding 32 as follows:—from the positive pole of the battery, through conductor 75, conductor 78, winding 32, through a part of the tip strand, contacts 39 and 37, through another part of the tip strand, contact 86, armature 55, tip strand, tip contact of the plug, tip spring of the spring jack 13', line limb a' , the switchhook and telephonic apparatus at the sub-station, line limb b' , sleeve strand of spring jack 13', sleeve contact of the plug, sleeve strand, conductor 77, winding 33 and conductor 71 to the negative pole of the battery. Winding 32 is thus energized, and the armature 40 is attracted whereby the springs 41 and 42 part contact. These contacts, as before stated, control the local circuit through the supervisory lamp 43, and this lamp is, therefore, extinguished upon the removal of the receiver from the switchhook at the called sub-station. As before stated, the contacts 41 and 42 also control the circuit through the locking relay 60, and when this circuit is opened by the removal of the receiver from the hook at the called station, the locking relay is deenergized, and on account of its mechanical connection with the selective apparatus releases the key $d48^1$. This immediately breaks connection between the ringing generator and the line, and the operator is notified by the extinction of the supervisory lamp 43 that the called subscriber has answered.

The subscribers are now connected for

telephonic conversation through the following circuit:—from the telephonic apparatus at sub-station A, through line limb *b*, sleeve contact of spring jack 13, sleeve contact of plug, sleeve strand, through condenser 22, contact 90, armature 82, sleeve contact of plug, sleeve spring of spring jack 13', line limb *b'*, telephonic apparatus at sub-station B', line limb *a'*, tip spring of spring jack 13', tip of plug, tip strand, through armature 55, contact 86, contacts 37 and 39 and condenser 21, tip of answering plug, tip spring of spring jack 13, line limb *a* and back to the telephonic apparatus at sub-station A, current being supplied to the line by the common battery S.

When the subscriber at sub-station A replaces his receiver on the hook, the circuit through the winding 23 is broken. Thus, the armature 27 is permitted to retract, since, as before stated, the winding 24 is energized to attract the armature 25 on account of contact between the plug sleeve contact and thimble 15. This release of the armature 27 allows the spring 28 to engage the spring 30, and the circuit through the supervisory lamp 31 is closed. Similarly, when the subscriber at sub-station B' has replaced his receiver on the hook, the circuit through winding 32 of the supervisory relay for the calling side is opened to allow the armature 40 to retract whereby the springs 41 and 42 are brought into engagement, thus closing the circuit through supervisory lamp 43. Being thereby notified that conversation has been completed, the operator removes the plugs from the jacks to restore the entire apparatus to its normal condition. The cord circuits may also be provided with a busy test arrangement controlled by the auxiliary contacts 91 and 92 of the operator's listening key. Before the calling plug is inserted in the jack of the called line, the operator, in order to test whether or not the line is busy, applies the tip of the plug to the jack thimble and actuates her listening key. If the line is busy, current will flow as follows:—from the negative pole of the battery, through conductor 71 and winding 33 of the supervisory relay connected with the busy cord circuit, through the sleeve contact, through the engaged thimble, through the tip of the applied testing plug, through the tip strand of the testing cord circuit, through armature 55 and contact 86 of the relay 54, through contacts 37 and 38, through conductor 93, through engaging test contacts 92 and 91, through conductor 94, through the test winding 95, through conductor 96 and through conductors 78 and 75 to the positive pole of the battery. This will cause the usual click in the operator's receiver, and she will be notified of the busy condition of the line. If the line is not busy, this circuit will not be closed through

the test winding, and the operator connects the calling plug with the jack of the line to be called and then proceeds as hereinbefore described.

The relative arrangement between the selective signaling apparatus and the cord circuits as herein described has been found to be very efficient and capable of being operated with a minimum expense.

It is a desirable feature that small signaling current generators may be employed, and it is evident from the foregoing that with the cord circuits at the exchange arranged in ringing divisions, better results may be obtained than by the employment of large ringing current generators to meet the demands which may be made upon them. With the arrangements as described herein, the current is distributed as to time, all ringing divisions being supplied with the same amount of current, there being, however, but one division supplied at a time. I wish to have my invention construed broadly, therefore, as providing means whereby the cord circuits in an exchange are divided into ringing divisions, each division being supplied with current after the cessation of the supply to another division, whereby motors of small power may be employed, the arrangement being such as to positively distribute the current among cord circuit groups as to time to prevent at any time an overdemand upon the current generators.

I do not wish to be limited to the exact arrangement and relation of the parts herein shown, as changes may be readily made by those skilled in the art without departing from the spirit and scope of my invention.

I claim as new and desire to secure by Letters Patent:

1. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, cord circuits at the central exchange, a source of ringing current at the central exchange, and means whereby said ringing current source may be periodically connected with each of said cord circuits successively.

2. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, cord circuits at the central exchange, a source of ringing current at the central exchange, and interrupter means whereby said source may be periodically connected with each of said cord circuits in regular successive order.

3. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, cord circuits at the central exchange, a source of ringing current at the central exchange, and means whereby said ringing current source may be effectively

connected with said cord circuits successively at regular intervals.

4. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-
phone lines, cord circuits at the central ex-
change divided into ringing divisions, a
source of ringing current at the central ex-
change, and means whereby said ringing cur-
rent source may be periodically connected
with each of said ringing divisions in regu-
lar successive order.

5. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-
phone lines, a plurality of groups of cord
circuits at the central exchange, a source of
ringing current at the central exchange, and
means whereby said ringing current source
may be periodically connected with each of
said cord circuit groups in regular succes-
sive order.

6. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-
phone lines, cord circuits at the central ex-
change arranged in a plurality of groups, a
source of ringing current at the central ex-
change adapted to be connected in parallel
of all the cord circuits in a single group, and
means whereby said ringing current source
may be periodically connected with each of
said cord circuit groups in regular succes-
sive order.

7. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-
phone lines, cord circuits at the central ex-
change arranged in a plurality of ringing
divisions, a source of ringing current at the
central exchange, and means whereby said
ringing current source may be periodically
connected with each of said cord circuit ring-
ing divisions in regular successive order.

8. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-
phone lines, cord circuits at the central ex-
change arranged into ringing divisions, a
source of current at the central exchange,
an interrupter for each of said cord circuit
groups, and means for successively connect-
ing said source of current through each of
said interrupters with the associated cord
circuit group.

9. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-
phone lines, cord circuits at the central ex-
change arranged into ringing divisions, a
source of ringing current at the central ex-
change, and an interrupter for each of said
cord circuit groups through which said
source of current is adapted to be connected
with its associated cord circuit ringing di-

vision, said interrupters being so timed rela-
tive to each other that their active periods
follow each other in regular successive order.

10. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-
phone lines, cord circuits at the central ex-
change arranged into ringing divisions, a
source of ringing current at the central ex-
change, an interrupter for each of said cord
circuit ringing divisions whereby said source
of ringing current may be successively con-
nected with each of said cord circuit ringing
divisions through its associated interrupter.

11. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-
phone lines, cord circuits at the central ex-
change arranged into ringing divisions, a
source of ringing current at the central ex-
change, an interrupter for each of said ring-
ing divisions, said interrupters being so
timed that their active periods follow one
another in regular successive order, and
switching apparatus whereby said source of
current may be connected with any of said
cord circuit ringing divisions through the
associated interrupter.

12. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-
phone lines, cord circuits at the central ex-
change arranged into a plurality of ringing
divisions, a source of ringing current at the
central exchange, and an interrupter for
each of said ringing divisions through which
said current source is adapted to be con-
nected with the associated ringing division,
said interrupters being so timed that the
active period of each interrupter begins im-
mediately upon the cessation of the active
period of another interrupter and is fol-
lowed immediately upon its cessation by the
active period of a succeeding interrupter.

13. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-
phone lines, cord circuits at the central ex-
change arranged into a plurality of ringing
divisions, a source of ringing current at the
central exchange normally disconnected from
the cord circuit, interrupters for said cord
circuit divisions through which said source
of current is adapted to be successively con-
nected thereto, a relay controlling the con-
nection of said source of current with the
cord circuit, and switch mechanism adapted
upon actuation to energize said relay and to
connect said source of current through an
interrupter with the contacts of said relay
whereby said current source may be con-
nected with the line.

14. In a telephone exchange system, the combination with a central exchange, of sub-
stations connected therewith through tele-

phone lines, cord circuits at the central exchange divided into a plurality of ringing divisions, a source of ringing current at the central exchange, an interrupter for each of said ringing divisions, a relay controlling the connection of said source with the cord circuit, switch mechanism for each of said ringing divisions adapted upon actuation to connect said source of current through the associated ringing current interrupter with the contacts of said relay, and interrupter means connected in the circuit of said relay, said switch mechanism being adapted to close the circuit through said relay, a source of current and said interrupters whereby said relay is periodically energized, said ringing current interrupter being adapted to close the circuit through said source of ringing current while said relay is energized.

15. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, cord circuits at the central exchange, a source of ringing current at the central exchange normally disconnected from the cord circuit, a relay controlling the connection of said source with the cord circuit, a second relay controlling the circuit for said first relay, and interrupter means for each of said cord circuits for periodically causing closure of said circuit to periodically cause action of the first relay to connect the source with the cord circuit.

16. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, cord circuits at the central exchange divided into a plurality of ringing divisions, a source of ringing current at the central exchange, a relay controlling the connection of said source of current to the cord circuit, interrupter means for the circuit of said relay, switch mechanism for closing the circuit through said relay, one of said interrupters and a source of current, a ringing current interrupter for each of said divisions, said switch mechanism being adapted upon actuation to connect said ringing current source through the associated ringing current interrupter with the contacts of said relay, said ringing current source being adapted to be connected with the cord circuit upon the periodical energization of said relay, said ringing current interrupter being so timed with reference to the associated relay circuit interrupter that said ringing circuit will be closed when said relay is energized to send ringing current over the line connected with said cord circuit.

17. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, cord circuits at the central exchange arranged in a plurality of ringing divisions, a ringing current source at the cen-

tral exchange, a relay for each cord circuit controlling the connection of said ringing source to the cord circuit, an interrupter for each of said cord circuit divisions serially included with the associated controlling relay and a common source of current, switch mechanism adapted upon actuation to close the circuit through said controlling relay, the associated interrupter and the source of current, a ringing current interrupter for each cord circuit division, said switch mechanism upon actuation being adapted to connect said ringing current source with the contacts of said controlling relay through said ringing current interrupter, said ringing current interrupter and said associated relay circuit interrupter being so relatively timed that said ringing current source will be connected with the cord circuit and the line connected therewith when said relay is energized.

18. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, cord circuits at the central exchange arranged into a plurality of ringing divisions, a source of ringing current at the central exchange normally disconnected from the cord circuits, a relay controlling the connection of said ringing current to the cord circuit, an interrupter for each of the cord circuit divisions serially included in the controlling relay circuit, a common source of current, switch mechanism for closing the circuit through said controlling relay, said associated interrupter and said common source of current, a second relay controlling the circuit of the first relay, said switch mechanism being adapted upon actuation to energize said relay to continue the circuit through said first relay, said second relay also forming locking means whereby said switch mechanism is held in an actuated position, a ringing current interrupter for each of said cord circuit divisions, said switch mechanism being adapted upon actuation to connect said source of current with the contacts of said first controlling relay, said relay circuit interrupters being adapted to periodically energize the first controlling relay, said ringing current interrupters being so timed relative to the associated relay circuit interrupters that the ringing current will be connected with the line during such energized period.

19. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, cord circuits arranged in groups at the central exchange, a source of ringing current, and interrupter means whereby said ringing current may be successively connected with each of said cord circuit groups.

20. In a telephone exchange system, the combination with a central exchange, of sub-

stations connected therewith through telephone lines, cord circuits for interconnecting said telephone lines arranged in groups at the central exchange, a source of ringing current, and an interrupter between said source of current and each cord circuit, said interrupters being so timed relatively to each other that said source of current is periodically connected with each of said cord circuit groups in regular successive order.

21. In a telephone exchange system, the combination with a central exchange, of substations connected therewith through telephone lines, interconnecting cord circuits arranged in groups at the central exchange, a source of signaling current at the central exchange, one limb of each of said cord circuits being adapted to be connected with one limb of each of all the other cord circuits

and with one terminal of said source of current, and an interrupter associated with each cord circuit group, one segment of each interrupter being connected with the corresponding segment of all the other interrupters and with one terminal of said source of current, the brush contact of said interrupter being adapted to be connected with the other limb of the associated cord circuit, said segments being so timed that said source of current will be periodically connected with each of said cord circuit groups in regular successive order.

In witness whereof, I hereunto subscribe my name this fifth day of Jan. A. D., 1907.

MERRITT S. CONNER.

Witnesses:

P. E. TUCKER,

WILLIAM RADFORD.