A. H. DYSON.

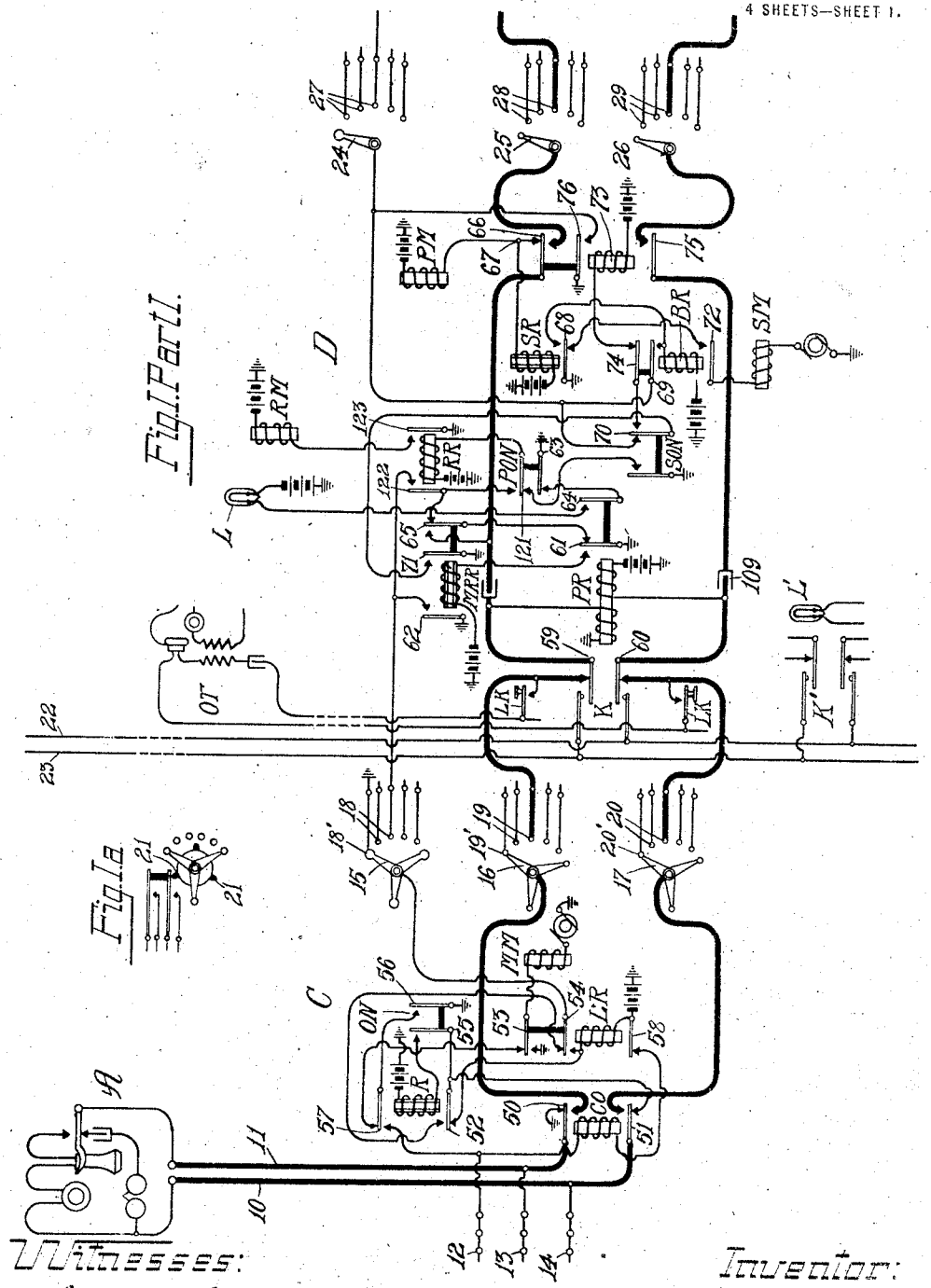
OPERATOR'S CALLING DEVICE.

APPLICATION FILED FEB. 23, 1911.

**1,173,564.**

Patented Feb. 29, 1916.

4 SHEETS—SHEET 1.

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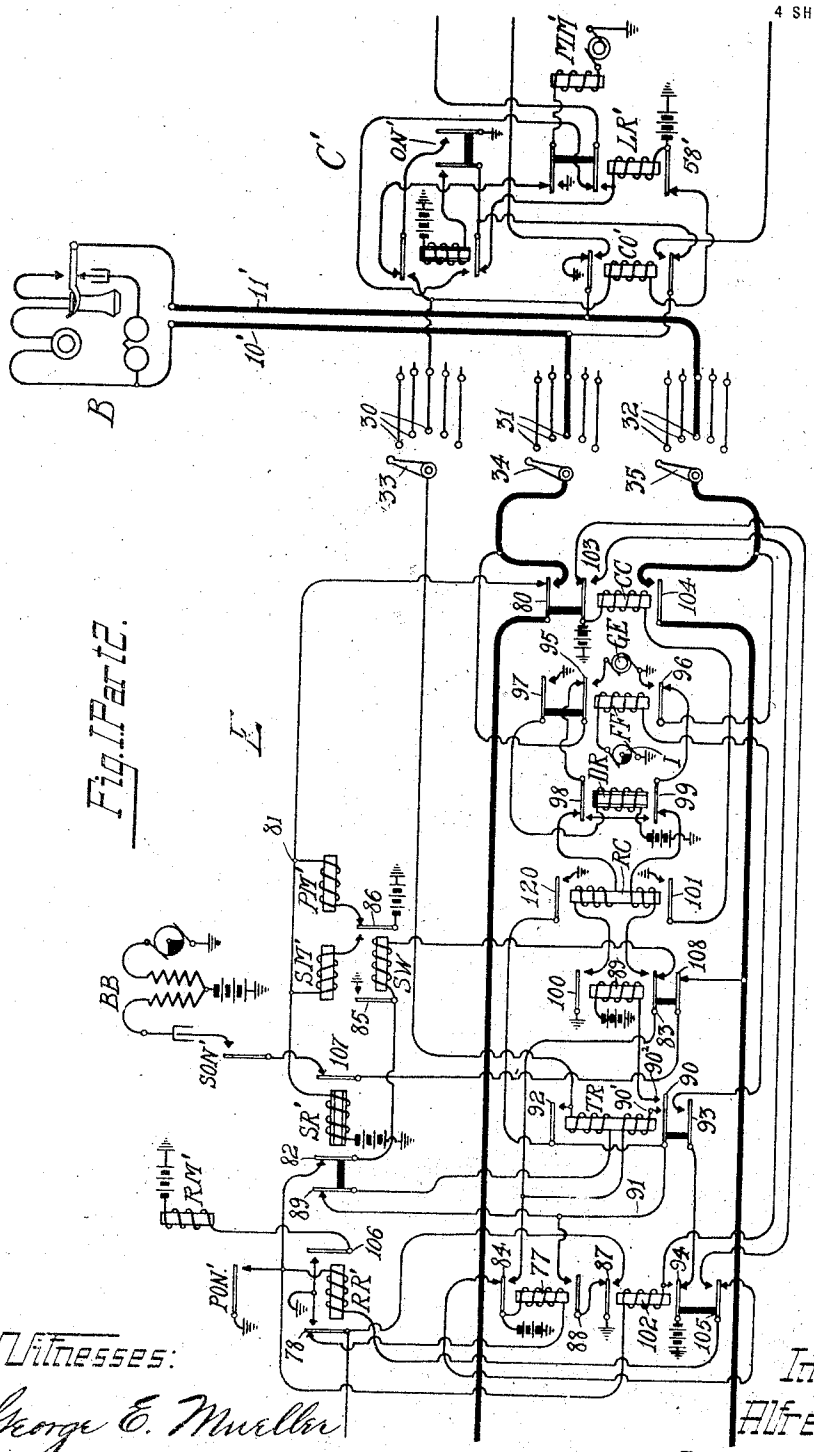


Fig. 1 Part 2.

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4 SHEETS—SHEET 3.

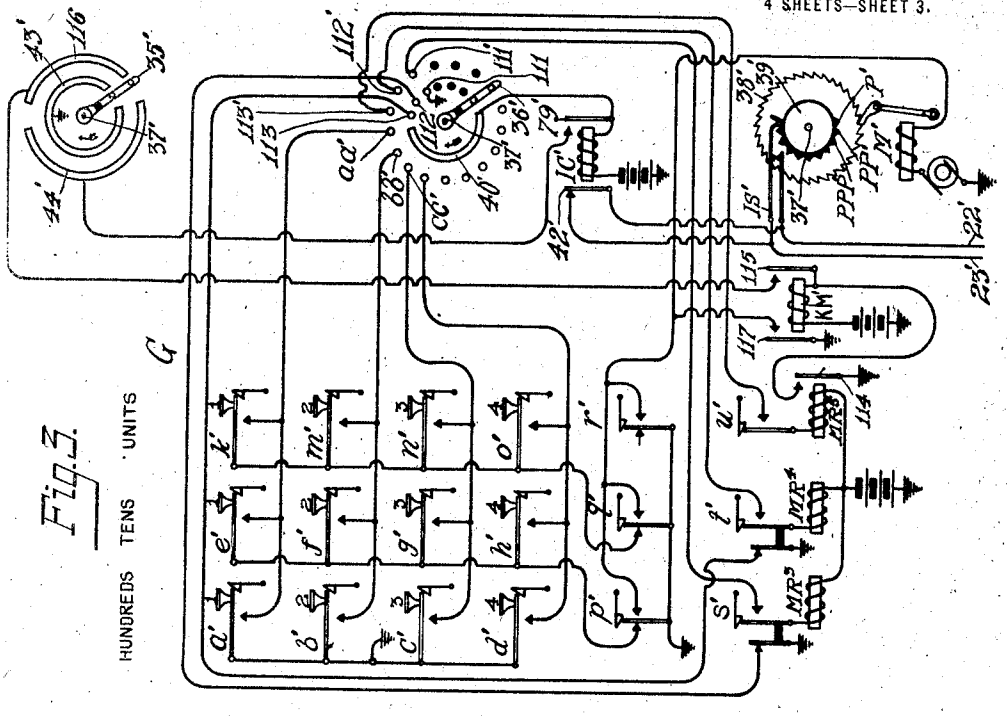

Fig. 1.

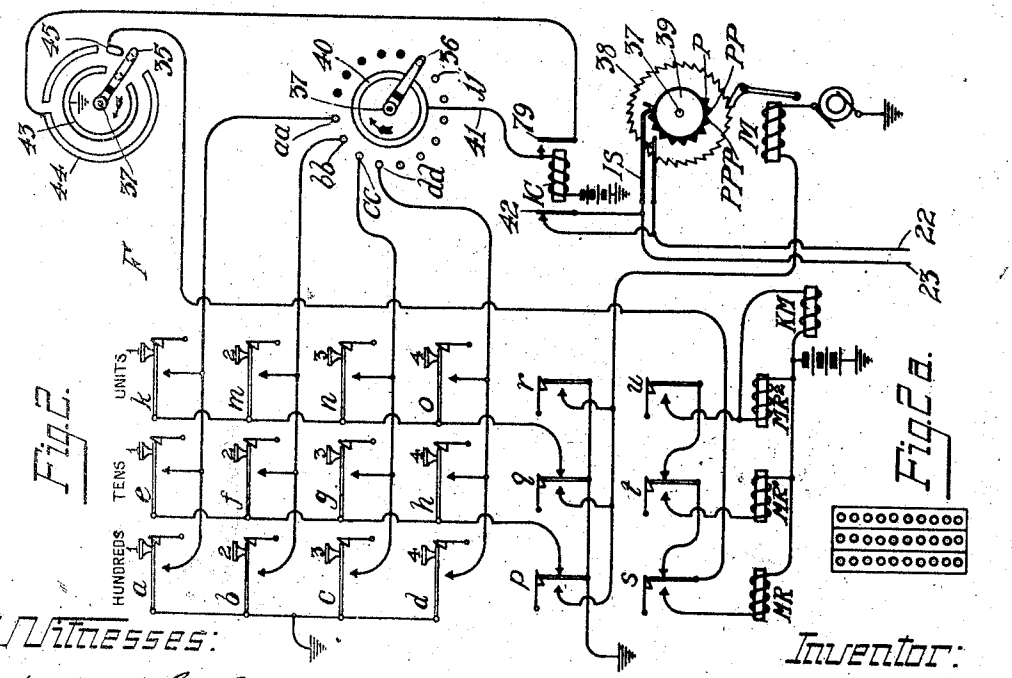

Fig. 2.

Fig. 2a.

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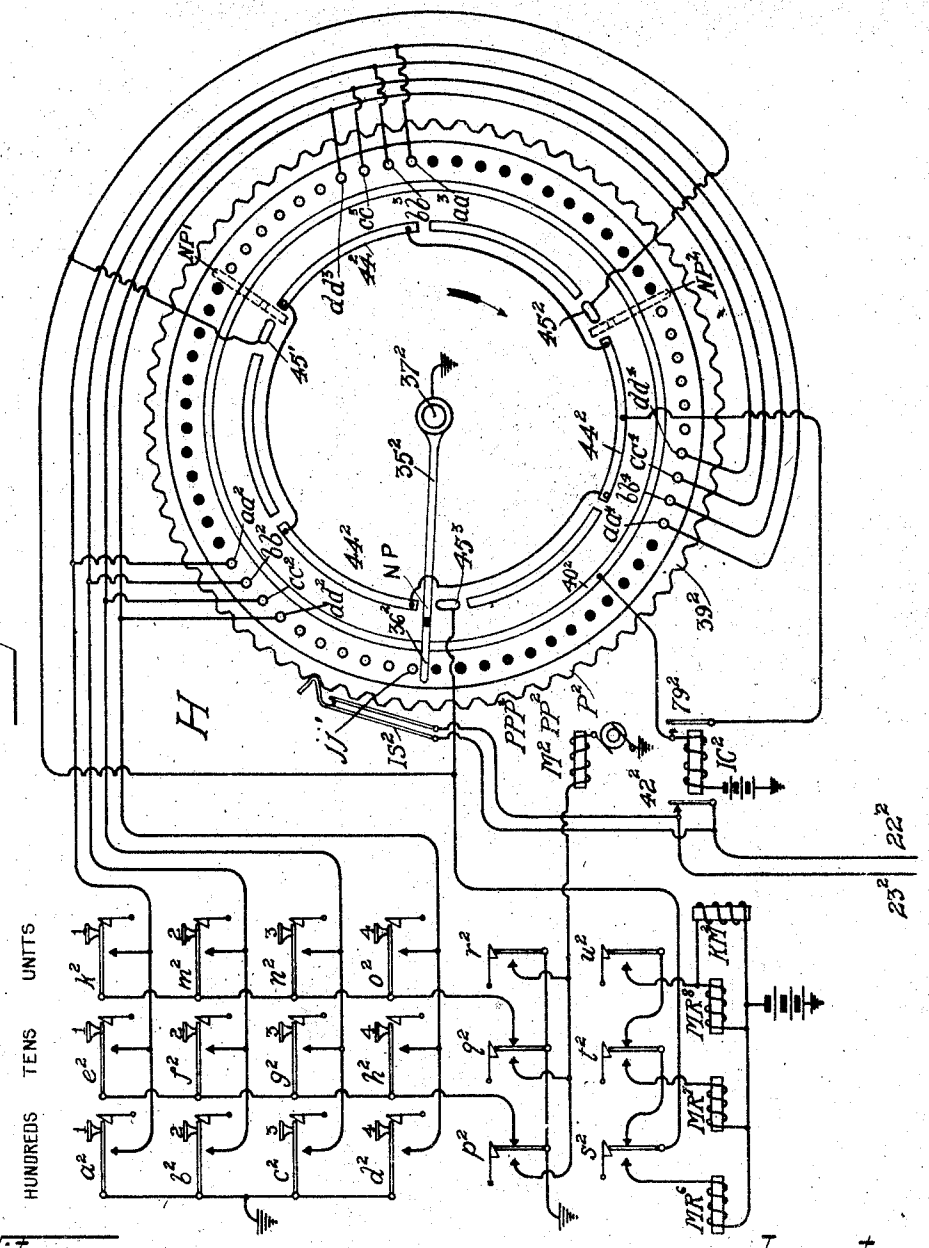
4 SHEETS—SHEET 4.

Fig. 4.

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# UNITED STATES PATENT OFFICE.

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## OPERATOR'S CALLING DEVICE.

1,173,564. Specification of Letters Patent. Patented Feb. 29, 1916.

Application filed February 23, 1911. Serial No. 610,420.

*To all whom it may concern:*

Be it known that I, ALFRED H. DYSON, a citizen of the United States of America, residing in Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Operators' Calling Devices, of which the following is a specification.

My invention has to do with calling devices for directively controlling automatic switches and more particularly to operators' impulse transmitters adapted for use in connection with semi-automatic telephone systems in which automatic switches are controlled by operators for connecting calling and called telephone lines, and is particularly applicable to two-wire or metallic line systems in which the automatic switches are directively controlled without the use of a ground connection at the calling device, although by slight variations of the impulse springs, it may be used for grounded systems.

My invention relates to the key controlled type of calling devices in which the usual finger hold dial or lever is not used but in which a single button or key is actuated for each series of impulses, the number of keys or buttons actuated depending upon the number of series of impulses in the set, the object being to provide such a device which is more simple of construction and of operation.

Many features will be apparent to those skilled in the art and which will be more particularly pointed out in the appended claims.

In the accompanying drawings which form part of my application, Figure 1, which includes Parts 1 and 2, illustrates diagrammatically a semi-automatic telephone system. Fig. 1ª illustrates the off-normal spring arrangement of line switch C. Fig. 2 illustrates one embodiment of my invention. Fig. 2ª shows arrangement of impulse keys before an operator. Fig. 3 is a modification of the structure illustrated in Fig. 2, and Fig. 4 is another modification of Fig. 2.

Referring now more particularly to Fig. 1, by placing Part 2 thereof to the right of Part 1, the operation of the system may be readily followed.

The system as illustrated in Fig. 1 is adapted for use as a thousand-line system and I show a calling sub-station A and called sub-station B, whose line conductors 10 and 11 terminate at the central exchange in a line switch C which is adapted upon initiation of a call from its sub-station to automatically select an idle first selector D, thus lighting a signal lamp L before an operator who by means of a calling device, such as shown in Figs. 2, 3 and 4, operates a first selector D and connector E to connect the calling and called lines.

The sub-station circuit arrangement may be of any desired form but I illustrate sub-station A which is a well known simple circuit arrangement. Said sub-station A is connected with line switch C by means of line conductors 10 and 11 which terminate at the contacts of the cut-off relay CO, and at the multiple terminals 12, 13 and 14 of connector switches having access to the lines of sub-station A.

Each line switch C, besides a cut-off relay CO, also includes a line relay LR, a motor magnet MM, release relay R and off normal springs ON. The wipers 15, 16 and 17 are adapted to coöperate with bank contacts 18, 19 and 20 respectively and assuming a basis of 10 per cent. trunking which is customary in exchanges of this character, there would be ten such sets of bank contacts 18, 19 and 20 for each line switch C. The line switch C is of ordinary rotary switch construction, the wipers 15, 16 and 17, which are mounted upon a single shaft being adapted to be rotated by means of motor magnet MM and suitable ratchet and pawl mechanisms, so that the said wipers 15, 16 and 17 step along from one contact set to the next upon each energization and deënergization of magnet MM. In the release of the switch the wipers are again advanced by motor magnet MM until the engaging set of wipers 15, 16 and 17 have advanced to a point beyond the last contact in the bank. The said bank contacts 18, 19 and 20 are so disposed that when a set of wiper arms 15, 16 and 17 have stepped one point beyond the last contact in the row, the next set of wiper arms are engaging the normal contacts 18′, 19′ and 20′. The off normal switch ON, a detail of which is shown in Fig. 1ª, is adapted to be moved to its alternate position upon the first off normal step of wipers 15, 16 and 17, and upon restoration of said wipers to normal, the next projection 21 restores off normal switch ON to normal. For each one hundred line switches C there are ten first

selectors D, so that each such first selector D would be multiply connected to one hundred line switches C, although I have shown but two such multiple connections.

Each first selector D has an associated key switch switch K and calling signal lamp L located at an operator's switchboard so that upon selection of an idle selector D upon initiation of a call, its signal lamp L will be lighted and the operator throws the said associated key K, thus connecting common conductors 22, 23 to the selected first selector.

The listening keys LK are of the ordinary type, there being one such key LK for each key K, so that the operator may connect her telephone OT with any of the selector switches D under her control. While I have illustrated but a single listening key LK it is to be understood that there is one such key for each calling device key K and that the operator's telephone OT is multiply connected to the said keys LK in a well known manner.

The selector and connector switches of Fig. 1 are adapted for operation with the switch of patent to W. Kaisling 975,530 or any switch of the same general type. Each first selector D also includes a primary relay PR which is adapted to transmit the primary directive impulses, a secondary relay SR, which starts the initial secondary operation of the wipers in selecting an idle trunk, a busy relay BR, which controls the selection of an idle trunk, a primary magnet PM which controls the primary movement of wipers 24, 25 and 26 and a secondary magnet SM which controls the secondary movement of the said wipers 24, 25 and 26, a main release relay MRR, which controls the release of several of the switches, a release relay RR, a release magnet RM, which releases the wipers 24, 25, 26, a primary off normal switch PON, which is moved to its alternate position upon the first primary step of the wipers and a secondary off normal switch SON, which is adapted to move to its alternate position upon the first secondary step of wipers 24, 25 and 26. Each selector switch D includes one hundred sets of bank contacts 27, 28, 29 arranged in ten groups of ten contact sets each. Wipers 24, 25, 26 which coöperate with said bank contacts 27, 28 and 29 respectively, are adapted to be moved in a primary direction to select a group of contacts depending upon the number of impulses transmitted from relay PR and are adapted then to be moved in a secondary direction to select a set of contacts 27, 28 and 29 of the selected group. Upon the release of the switch D, wipers 24, 25 and 26 are first restored from their secondary movement thereby restoring switch SON and are thereafter restored from their primary movement, thereby restoring switch PON. Assuming a basis of ten per cent. trunking, as previously stated, there would be one hundred such first selectors D, divided into ten groups, there being ten selectors for each group of one hundred lines, and accordingly there would be one hundred connector switches E divided into ten groups of ten switches for each one hundred lines.

The connector switches E are of the same general type as first selectors D and the magnets and mechanism of connectors E, which have functions corresponding to similar magnets and mechanism of first selector D, have the same reference characters but with the suffix "′". Each connector switch also includes a test relay TR for testing the idle or busy condition of a called line, an interrupter or flip flop relay FF, for intermittently connecting ringing current to the terminals of the called line, the ringing control relay RC which is adapted upon response of a called subscriber to disconnect the ringing current, a discharge relay DR which momentarily short circuits the called line after each application of ringing current, a circuit closing relay CC, and several other relays whose functions will be more particularly pointed out in the description of the operation of the system. Each connector switch includes one hundred sets of bank contacts 30, 31 and 32 divided into ten groups of ten contact sets each and the wipers 33, 34 and 35 are adapted to cooperate with the said bank contacts.

Line switch C′ is similar to that of line switch C, the corresponding parts having corresponding reference characters with the suffix "′" added in switch C′.

*Fig. 2.*—Calling device F of Fig. 2 which is adapted to be connected with selector D by means of conductors 22 and 23, is preferably arranged common to a group of such switches D, preferably ten in number, although this grouping may be arranged to suit existing conditions, or a device may be arranged individual to each selector. Assuming there would be one calling device for each ten switches D, there would be ten keys K, K′, etc., and their corresponding signal lamps L, L′, etc., arranged before an operator. For each calling device F there would be preferably arranged three rows of impulse buttons as illustrated in Fig. 2ª, each row representing the digits from 1 to 10 and each button being adapted to control the transmitting of impulses corresponding to its number, as for instance number five in any row when actuated would cause the calling device to transmit five impulses. The left row would include ten sets of springs *a*, *b*, *c*, *d*, etc., the middle row would include ten sets of springs *e*, *f*, *g*, *h*, etc., and the right row would include ten sets of springs *k*, *m*, *n*, *o*, etc.

Each contact spring *a*, *b*, etc. is arranged to be locked in its actuated position, thus maintaining the connection with its coöperating contact closed until released from its locked position. The key contact springs *p* and *s* are common to the left or hundreds row of springs *a*, *b*, etc., and are adapted to be moved and locked in their alternate position upon actuation of any of the associated springs *a*, *b*, etc. Key contact springs *q* and *t* are similarly common to the middle or tens row of contacts *e*, *f*, etc., while key contact springs *r* and *u* are common to the right or units row of springs *k*, *m*, etc. Thus assuming the operator actuates key springs *a*, springs *p* and *s* would also be actuated and the three sets of springs *a*, *p* and *s* would be locked in their alternate position. The said springs *a*, *p*, and *s* are adapted to be restored by the magnet MR, the said magnet being so arranged that the said springs are restored by the deënergization thereof. The tens row of springs and the units row are controlled in a similar manner by magnets MR′ and MR² respectively. Key release magnet KM is adapted, upon operation to release the keys K, K′, etc., which are common to calling device F, the said magnet KM being preferably adapted to release the keys upon its deënergization. While there would be ten such keys K, K′, etc., for calling device F, the said keys would be disposed before the operator with the impulse keys *a*, *b*, etc., and while the said keys K are initially thrown by the operator, they are restored by the operation of magnet KM which is preferably arranged common to the ten keys K, etc. Although the lamps L and L′ are shown in Fig. 1, Part 1, it is to be understood that they would be arranged before the operator in such a manner that upon the lighting of any of the said lamps, the operator would know which corresponding key K to actuate thus connecting her calling device F with the proper first selector D.

The rotating mechanism of calling device F includes wipers 35 and 36, which are mounted on shaft 37, the ratchet wheel 38 and impulse wheel 39 being also rigidly secured to the same shaft 37, the said wipers being suitably insulated from the said shaft. Motor magnet M with its armature and actuating pawl, is adapted upon each operation of said magnet M to advance ratchet wheel 38 one tooth, while the teeth of impulse wheel 39 are so divided that there are two teeth of ratchet wheel 38 for each tooth of impulse wheel 39. Impulse springs IS rest in engagement with impulse wheel 39 which is preferably arranged so that it requires two operations of magnet M to step the outer point of the first tooth of impulse wheel 39 into engagement with impulse springs IS so as to open their contact. The next step of magnet M advances impulse wheel 39 so that springs IS again close their contacts. Then upon further operation it will be seen that one step of magnet M opens contact springs IS and the next step again closes them, although on the initial operation of the device the said springs IS do not have their contacts opened until the second step of magnet M. The contacts *aa*, *bb*, etc., are so disposed that it requires two steps of magnet MM to advance wipers 36 from engagement with one contact into engagement with the next, and wiper 36 is so adjusted that it requires two steps of magnet M to advance it into engagement with the first contact *jj*. The common ring 40 is engaged by wiper 36 and is connected to impulse controlling relay IC by means of conductor 41, thus wiper 36 is adapted to connect relay IC to any one of the contacts *aa*, *bb*, etc. The contacts *aa*, *bb*, etc., and relay IC jointly control the number of impulses transmitted by springs IS, by means of contacts 42, which are normally in shunt of contact springs IS. In the operation of the calling device F if it is desired to transmit a single impulse, the potential of contact *aa* is varied, preferably by grounding the same, and therefore when magnet M is operated, thereby opening and closing impulse springs IS, these springs have no effect upon the metallic circuit of conductors 22 and 23 until relay IC is energized upon wiper 36 reaching a grounded contact, thereby removing the shunt from impulse springs IS.

Wiper 35 is adapted to be moved upon the second step of magnet M, into engagement with rings 43 and 44, and moves out of engagement with the ring 44 at the same time wiper 36 steps off of contact *aa*. Contact 45 is adapted to be connected to the grounded ring 43 by means of wiper 35 for the purpose of actuating magnets MR for the release of the actuated buttons *a*, *e*, *k*, etc. In the key arrangement *a*, *e*, *k*, etc., of calling device F but four keys of each row are illustrated, the upper keys marked with the figure 1, being adapted to transmit a single impulse from calling device F, the second key from the top marked with the figure 2, being adapted to transmit two impulses, the third key 3, the fourth key 4, etc. up to ten impulses. There are ten contacts, *aa*, *bb*, etc., illustrated, but only the first four are connected to keys *aa*, *bb*, *cc*, etc., and it will be understood that in using ten keys, they would connect to the other contacts in regular order.

In the device as illustrated three rows of keys are shown, this arrangement being adapted for a thousand line system, the calls ranging from 000 to 999, the row at the left being the hundreds digits, the middle row being the tens digits and the righthand row

the units digits. Thus, if the operator desires to call the line No. 234, she would first press key *b*, then key *g* and then key *o*, thereby also actuating all of the spring sets *p*, *q*, *r*, *s*, *t*, *u*. The actuation of the said keys closes alternate contacts *p*, *q*, *r*, thereby causing magnet M to step the shaft 37 three complete revolutions, or one revolution for each series of impulses to be transmitted. Although as soon as magnet M starts the advance or rotation of shaft 37, impulse springs IS are immediately operated by the projections on impulse wheel 39, the opening of the springs IS has no effect upon the metallic circuit including conductors 22 and 23, due to the shunt through contacts 42, until relay IC is energized, due to wiper 36 engaging contact *bb* grounded by the operation of the impulse key *b*.

Upon the first revolution of shaft 37, impulses are transmitted in number according to the key actuated, and in this instance key *b* having been the one actuated in the hundreds row, two impulses are transmitted and shaft 37 continuing in its movement, magnet MR releases the actuated contact springs in the hundreds row, thus connecting a ground through normal contact *p*, to the actuated key *g*, thereby grounding contact *cc*.

Upon the next or second revolution of shaft 37, a number of impulses are transmitted by springs IS, depending upon the key in the tens row actuated; in this instance the key *g* being the one actuated. As the shaft 37 completes its second revolution magnet MR′ is operated to restore the actuated contact springs in the tens row, thereby removing ground from contact *cc*, due to the restoration of key *g*, and connecting ground through normal contact *q* and contact of key 0 to contact *dd*.

Upon the next or third revolution of shaft 37, the operation of impulse springs IS has no effect upon the metallic circuit including conductors 22 and 23 until relay IC is energized responsive to wiper 36 engaging the grounded contact *dd*, and as shaft 37 advances toward normal magnets $MR^2$ and KM are operated, thereby restoring the actuated contact springs in the units row by means of magnet $MR^2$ and restoring the actuated key K by means of magnet KM. All of the contact springs *p*, *q*, and *r* having been restored, the motor magnet M remains inert, thus allowing shaft 37 to remain at normal until another set of impulses is to be transmitted.

*Fig. 3.*—The calling device G of Fig. 3 is controlled by means of its keys *a′*, *b′*, etc., similar to the device of Fig. 2. The parts having similar functions in the two devices F and G have similar reference characters but using a different suffix in the case of calling device G. In calling device G the release magnets $MR^3$, etc., are controlled through wiper 36′ instead of through wiper 35 as was the case in calling device F.

*Fig. 4.*—The calling device H which is a modification of the calling device F, has the keys $a^2$, $b^2$, etc., arranged similar to Fig. $2^a$ and are operated in a similar manner to the keys of calling device F. In the calling device F the wipers 35 and 36 make one complete revolution for each digit or series of impulses, thus making three complete revolutions for three series, or a complete set of impulses, while in the calling device H the wipers $35^2$ and $36^2$ move from one normal position NP to the succeeding position NP′ for each series of impulses, and for one complete set of three series of impulses said wipers $35^2$ and $36^2$ move from one normal lution passing over the three divisions. The release magnets $MR^6$, etc., and key magnet $KM^2$, are controlled over contacts 45′, $45^2$ and $45^3$ from grounded wiper $35^2$. The impulse wheel $39^2$ is also carried by shaft $37^2$, thus moving along with wipers $35^2$ and $36^2$ and operating impulse springs $IS^2$. In calling device H, two operations of magnet $M^2$ are also necessary to step the wipers from one contact to the next similar to F and G, the projections on impulse wheel $39^2$ also requiring two actuations of magnet $M^2$ to operate springs $IS^2$ a single time. Parts of calling device H having functions similar to parts of calling device F have similar reference characters but with a different suffix.

*Operation of system including Fig. 2.*—Having described in general the location and arrangement of apparatus of the system embodying my invention I will now describe the operation thereof. Assuming a calling subscriber at sub-station A desires to connect with sub-station B, whose number we will assume is 123, the subscriber at sub-station A removes his receiver from its switch hook, thereby establishing a circuit for line relay LR traced from ground at normal contact 50, line conductor 11, upper switch hook contact, through transmitter of sub-station A, returning over line conductor 10, normal contact 51, normal contact 52, winding of relay LR to battery, energizing said relay LR and closing a circuit for motor magnet MM from ground through alternate contact 53, the winding of magnet MM to alternating current generator. Motor magnet MM is thereupon energized stepping wipers 15, 16 and 17 into engagement with the first set of contacts 18, 19 and 20 respectively, which we will assume leads to a busy first selector D. Therefore there would be a ground or busy condition upon private contact 18, thus establishing a locking circuit for relay LR through contact 54. Upon the first step off normal, a circuit for relay R is established from ground at normal contact 50, line conductors 11 and 10, normal contact 51,

alternate contact 55 of switch ON which is now in its alternate position, and the winding of said relay R to battery, energizing relay R. Relay LR remaining energized over the locking circuit just mentioned, magnet MM advances wipers 15, 16 and 17 another step into engagement with the next set of contacts 18, 19 and 20 which we will assume are the contacts leading to first selector switch D which is in an idle condition as illustrated. Said switch being idle there would be no ground upon its private contact 18 and relay LR would deënergize, opening the circuit for magnet MM and preventing any further advance of wipers 15, 16 and 17. Also upon deënergization of relay LR a circuit for cutoff relay CO is established from ground through alternate contact 56, alternate contact 57, the winding of relay CO to battery at normal contact 58, energizing relay CO and thereby connecting the line of sub-station A to first selector D. Although the relay R has its energizing circuit interrupted upon the energization of relay CO, said relay R being a slow acting relay, does not retract its armature immediately but maintains its armature until a locking circuit is established from first selector D as will be described.

The relay CO having connected the calling line with the first selector D, a circuit for primary relay PR is established from ground through the left-hand winding of relay PR, normal contact 59, contact 19, wiper 16, alternate contact 50, line conductor 11, sub-station A, line conductor 10, alternate contact 51, wiper 17, contact 20, normal contact 60 and the right hand winding of relay PR to battery, energizing relay PR and closing a circuit through main release relay MRR from ground through alternate contact 61, and the winding of relay MRR to battery. Relay MRR thereupon energizes, closing alternate contact 62, thereby establishing a locking circuit for r. y R of line switch C.

Also, upon energization of relay PR a circuit for signal lamp L is established from ground through normal contact 63, alternate contact 64, the said lamp L to battery, lighting the said lamp and thereby notifying the operator that a calling subscriber has connected with the first selector D associated with key K.

The operator in response to the said signal throws listening key LK, connecting the operator's telephone OT with the calling substation. The operator now ascertains the wants of the calling subscriber and finding that the calling subscriber desires connection with the sub-station B, which we will assume is No. 123, the operator restores key LK thereby disconnecting the telephone OT and then throws key K, thereby closing alternate contacts 59 and 60, removing the substation control of relay PR and substituting a circuit for said relay PR including conductors 22, 23 and impulse springs IS of calling device F.

We have assumed that the number of the called substation is 123 and therefore to operate the switches to connect the two subscribers for conversation a set of three series of impulses are to be transmitted, the first series being one impulse, the second two impulses and the third three impulses, and therefore the operator now actuates keys *a*, *f* and *n*, locking the said keys in their actuated position and thereby also moving springs *p*, *q*, *r*, *s*, *t*, *u*, to their alternate position. The actuation of key *a* connects ground to contact *aa* and although the keys *f* and *n* have been actuated the contact springs *p* and *q* being in their alternate position, the said keys *f* and *n* do not connect ground to contacts *cc* and *bb* until the contact springs *p* and *q* are restored to normal in their regular order, as will be more fully described. A circuit for motor magnet M is closed responsive to the actuation of said keys, traced from ground, through each of the alternate contacts *p*, *q*, and *r*, through the winding of said magnet M to alternating current generator. Magnet M is thereupon operated rotating shaft 37, and upon the second step of magnet M, wiper 35 is moved into engagement with rings 43, 44 but without any effect upon the apparatus, wiper 36 is moved into engagement with contact *jj* and the upper spring IS rests on the outer point of the first projection of impulse wheel 39, but the contact 42 of relay IC being closed, the opening of the contact IS has no effect upon relay PR. Motor magnet M continues in its operation until wiper 36 engages contact *aa*, closing an energizing circuit for relay IC from ground through actuated key contact *a*, contact *aa*, wiper 36, ring 40, conductor 41 and the winding of relay IC to battery, energizing said relay IC, opening contact 42 and as the springs IS are open at this time due to upper spring IS resting on the tip of projection P, the circuit for relay PR is interrupted allowing the said relay to deënergize, but upon the next step of motor magnet M, contact springs IS are closed again thereby closing an energizing circuit through relay PR. Thus it will be seen that the circuit of relay PR has been interrupted a single time thereby transmitting a single impulse as will be more fully described. Motor magnet M continues the advance of shaft 37, until wiper 35 engages contact 45, closing a circuit through release magnet MR traced from grounded ring 43, wiper 35, contact 45, alternate contact *s*, winding of release magnet MR to battery, energizing the said magnet MR which remains energized until wiper 35 steps off of contact 45 to its normal position,

thereby allowing magnet MR to deënergize, restoring key *a* and contact springs *p* and *s*.

From the foregoing description it will be seen that the operator having pressed key *a* in the hundreds row, the magnet M has rotated the shaft 37 one complete revolution and although the springs IS were opened and closed ten times, the circuit of relay PR was interrupted only a single time, due to the fact that relay IC maintained a shunt about springs IS until wiper 36 reached contact *aa*.

Referring now to first selector D, relay PR having been deënergized and again energized a single time, upon its said deënergization a circuit for magnet PM and secondary relay SR was established from ground through normal contact 61, alternate contact 65, normal contact 66, to point 67, there dividing and including the windings of magnet PM and secondary relay SR, energizing both magnet PM and relay SR. Responsive to energization of relay SR a circuit for relay BR is established from ground through alternate contact 68, winding of relay BR to battery, which is thereupon energized, establishing a locking circuit for itself through alternate contact 69, normal contact 70 to ground at alternate contact 71. Responsive to the single impulse of current through magnet PM, wipers 24, 25 and 26 are advanced one step to select the first group of contacts 27, 28 and 29, and after the cessation of said impulse, relay SR, which is a slow relay, deënergizes, closing a circuit through secondary magnet SM from ground to normal contact 68, alternate contact 72, winding of magnet SM to alternating current generator. Magnet SM thereupon advances wipers 24, 25 and 26 into engagement with the first set of contacts 27, 28 and 29, and assuming these contacts lead to a busy connector switch E, the first private contact 27 will be grounded and a locking circuit for relay BR will be established from the said ground, to wiper 24, alternate contact 69, thereby maintaining relay BR energized from this new locking circuit, as switch SON having moved to its alternate position upon the first secondary step of the wipers, the initial locking circuit for relay BR was opened at normal contact 70. The relay BR having been maintained energized, magnet SM advances wipers 24, 25 and 26 into engagement with the next set of contacts, and assuming these contacts also lead to a busy connector switch E, relay BR is maintained energized and magnet SM continues to advance the wipers until they connect with a set of contacts leading to an idle connector switch E which has an ungrounded private contact 27, thus interrupting the circuit for relay BR allowing the said relay to deënergize and interrupt the circuit for magnet SM, thereby preventing any further advance of wipers 24, 25 and 26.

Upon deënergization of relay BR a circuit for relay 73 is established from ground through alternate contact 71 of relay MRR, alternate contact 70, normal contact 74 and the winding of relay 73 to battery, energizing the said relay, closing contacts 66 and 75 and also closing contact 76 and connecting ground to wiper 24, thus maintaining the private contacts 27 leading to connector switch E grounded, and preventing any other first selector from connecting therewith.

Although upon deënergization of relay PR the circuit through relay MRR is interrupted for a short period, said relay being a slow relay does not retract its armature.

The lamp L which was lighted at the time switch D was selected, had its circuit interrupted upon the first primary step of wipers 24, 25 and 26, due to the opening of contact 63 of switch PON, and the said signal is effaced.

Referring now to connector switch E, upon the connection of ground to private contact 27, relay 77 of switch E is energized, the circuit being traced from the said ground through normal contact 78 and the winding of relay 77 to battery, but this has no effect at this time.

From the foregoing description it will be seen that the wipers of the calling device have made one revolution, thereby transmitting a single impulse, responsive to which the first selector D selected an idle connector switch E in the first group of ten trunks. As the impulse springs IS close after leaving projection P, the wiper 36 is one-half of a step to the right of contact *aa* and therefore the next series of impulses are not transmitted until after wiper 36 is stepped around to its normal position. Thus while the wiper 36 is stepping from one tooth beyond contact *aa* over the dead contacts to its normal position, the slow or secondary relay SR of first selector D has time to deënergize and allow selector D to select an idle trunk, before the next series of impulses is transmitted. This distance from contact *aa* to the normal position of wiper 36 may be varied according to the time required for the switches to perform their function after the last directive impulse has been transmitted and before the calling device is in position to transmit another series of impulses. In other words this space is simply to allow the selector switch time to select an idle trunk before the next set of impulses are to be transmitted.

Returning now to calling device F, the shaft 37 having made one complete revolution as described, magnet M continues to rotate the shaft 37 due to the ground connection from alternate contact *q*, it being re-

membered that the operator has actuated key *f* in the tens row, and therefore magnet M continues to rotate shaft 37, until wiper 36 engages contact *bb*, which is grounded through key *f*. At this time the upper spring IS is resting upon the tip of projection PP thereby interrupting the contact with the fellow spring. As the wiper 36 engages contact *bb* a circuit for relay IC is established from ground, through normal contact *p*, alternate contact *f*, contact *bb*, wiper 36, ring 40, conductor 41 and the winding of relay IC to battery, energizing the said relay which establishes a locking circuit for itself through contact 79, ring 44 and wiper 35 to grounded ring 43. Thus, the contact 42 of relay IC being opened the shunt about springs IS is removed and magnet M continuing to advance or rotate shaft 37, the springs IS are again closed and are once more operated by projection P, thereby interrupting the circuit of relay PR two times through impulse springs IS. As the projection P leaves impulse springs IS, allowing them to close after the last interruption, wiper 35 moves off of ring 44, thus interrupting the locking circuit for relay IC which deënergizes, restoring the said shunt circuit about the said impulse springs IS. It will be seen that in this second rotation of the shaft 37, that the last interruption of springs IS is effected as wiper 36 leaves the contact *aa* and no more impulses may be transmitted until the wiper 36 reaches normal and starts its next revolution.

Referring now to the relay PR, its circuit having been interrupted two times at impulse springs IS as described, two impulses of current are transmitted to relay SR′ and magnet PM′ of connector E, from ground through normal contact 61, alternate contact 65, alternate contact 66, wiper 25, contact 28, normal contact 80, to point 81, there dividing and passing through magnet PM′ to battery and through slow secondary relay SR′ to battery, energizing the said relay SR′ which maintains its armature in an attracted position until the last impulse of the series has been transmitted. Responsive to the two said impulses of current primary magnet PM′ advances wipers 33, 34 and 35 to the second group of contacts, the said group including the contacts 30, 31 and 32 which are the terminals of the called substation B. After the last impulse relay SR′ deënergizes, closing a circuit for switching relay SW from ground through alternate contact PON′ which is now closed, normal contact 82, winding of relay SW, normal contact 83, to battery at alternate contact 84, energizing relay SW which establishes a locking circuit for itself through alternate contact 85 and by means of contact 86 disconnecting battery from magnet PM′ and connecting said battery to the secondary magnet SM′.

Returning now to the calling device F, which has made two revolutions, upon the next revolution of shaft 37 three impulses are to be transmitted as it will be remembered that key *n* has been actuated in the units row, therefore when the point of projection PPP interrupts the connection between contacts IS, wiper 36 is in engagement with contact *cc*, thereby establishing an energizing circuit for relay IC, traced from ground through normal contact *q*, key contact *n*, contact *cc*, wiper 36, conductor 41 and the winding of relay IC to battery, energizing the said relay, removing the shunt about springs IS and also by means of contact 79 establishing a locking circuit through ring 44, wiper 35 to grounded ring 43 as previously described. Magnet M continues to rotate shaft 37 thereby causing two more interruptions of impulse springs IS by projections PP and P, and after the last impulse as wiper 35 leaves ring 43, relay IC is deënergized. From this it will be seen that upon the last revolution of shaft 37, three interruptions of the circuit through relay PR were effected and as the shaft continues to rotate toward normal and upon engagement of wiper 35 with contact 45, a circuit for release magnet $MR^2$ is established from grounded ring 43, wiper 35, contact 45, normal contact *s*, normal contact *t*, alternate contact *u*, then dividing and including the windings of magnets $MR^2$ and KM to battery. As wiper 35 steps out of engagement with contact 45 and into its normal position, the circuit through the said magnets $MR^2$ and KM is interrupted and magnet $MR^2$ deënergizing, restores key *n* and springs *r* and *u* to normal. The restoration of contact spring *r* interrupts the circuit through motor magnet M thereby preventing any further actuation thereof. Upon restoration of magnet KM key springs K are restored thereby disconnecting calling device F from first selector D and again including relay PR in circuit with the line of the calling substation, and calling device F is now available for further use in establishing other connections.

Referring again to the connector E of Fig. 1 the effect of the last three impulses from primary relay PR will now be described. Responsive to the said three impulses of current from ground at normal contact 61 of relay PR, magnet SM′ and secondary relay SR′ are energized, the said relay SR′, maintaining its armature in an attracted position during the sending of the said impulses and magnet SM′ stepping wipers 33, 34 and 35 in a secondary direction into engagement with contacts 30, 31 and 32 which are the terminals of the called substation B.

After the last impulse relay SR′ deënergizes, and assuming the line of the called substation B is idle there will be no ground upon private contact 30 and an energizing circuit for relay TR and cutoff relay CO′ is established, traced from ground at normal contact 87, alternate contact 88, normal contact 89, the upper winding of test relay TR, wiper 33, contact 30 and the winding of relay CO′ to battery at normal contact 58′, energizing relays TR and CO′. The energization of relay CO′ removes the substation control of line switch C′ and upon energization of test relay TR, a locking circuit for itself is established through contacts 90 and 90′ to battery at alternate contact 84, from ground at normal contact 87, alternate contact 88, conductor 91 to contact 90. This same ground connection is extended to contact 92 which is now closed, thereby placing a shunt around the upper winding of relay TR, and connecting a direct ground to wiper 33 and the multiple contacts 30, thus preventing any other connector switch from establishing connection with the terminals of the line of substation B.

Also, responsive to energization of relay TR contacts 90 and 90² are closed, thereby establishing an energizing circuit for relay 89 which attracts its armature, thereby interrupting the circuit through switching relay SW, due to the opening of normal contact 83, and upon the closing of alternate contact 93 of relay TR a circuit for relay FF is established from battery through normal contact 94, alternate contact 93, the winding of relay FF through interrupter I to ground. thereby causing relay FF to attract and retract its armature in a well known manner. Upon each energization of relay FF ringing current from generator GE is connected to the terminals of the called line to ring the bell of the called substation B, the circuit being traced from the upper terminal of generator GE, alternate contact 95, wiper 34, contact 31, conductor 10′, call bell and condenser of substation B, returning over conductor 11′, contact 32, wiper 35, alternate contact 96, to the other pole of generator GE. Also, upon energization of relay FF a circuit for the slow-acting discharge relay DR is closed from ground through alternate contact 97, the winding of relay DR to battery, energizing the said relay and closing alternate contacts 98 and 99. Now upon deënergization of relay FF, it will be seen that due to the closing of said alternate contacts 98 and 99, the line of substation B will be short circuited, thus causing a discharge of the said line and its bridged condenser of any accumulated static charge from the application of ringing current. This discharge is for the purpose of preventing a premature operation of relay RC. It will be noted that relay DR is a slow acting relay and therefore maintains its armature momentarily attracted after the interruption of its circuit at contact 97, but upon deënergization of relay DR relay RC has its windings connected in bridge of the called line. From this it will be seen that generator GE and relay RC are alternately connected in bridge of the called line upon each operation of relay FF. Relay FF continues to operate until the called subscriber in response to actuation of his call bell, removes his receiver from its switch hook when, upon deënergization of relays FF and DR, a circuit through relay RC is established from ground through alternate contact 100, the upper winding of relay RC, normal contact 98, normal contact 95, wiper 34, contact 31, conductor 10′, substation B, returning over conductor 11′, contact 32, wiper 35, normal contact 96, normal contact 99, the lower winding of relay RC, alternate contact 83 to battery at alternate contact 84, thus energizing relay RC and establishing a circuit through circuit closing relay CC from ground through alternate contact 101 and the winding of relay CC to battery. Responsive to operation of relay CC a circuit for relay 102 is established from ground at contact PON′, winding of relay 102, to battery at alternate contact 103, energizing relay 102 which establishes a locking circuit for itself through alternate contact 94 to battery. Upon the opening of normal contact 94 the circuit for relay FF is interrupted, thus rendering said relay inert. Upon the opening of normal contact 87 of relay 102, the initial ground connection to relay TR is removed but relay RC having been energized before relay 102 deënergized, a substitute ground was connected to armature 90, traced from ground through alternate contact 120 of relay RC.

Upon the closing of alternate contacts 80 and 104 of relay CC, the circuit from substation A to substation B was completed, being traced over the heavily marked conductors, talking current for the calling substation being furnished from battery through the windings of relay PR while talking current for the called substation B is supplied from battery through the windings of relay RC over the previously described path.

*Release of automatic switches.*—After the subscribers have finished conversation they may, by replacing their receivers upon their switch hooks, restore the switches which were used in establishing the connection, the calling subscriber controlling the release of line switch C and first selector D, and the called subscriber B controlling the release of connector switch E. When the calling subscriber at substation A replaces his re-

ceiver upon its switch hook the circuit for relay PR is interrupted allowing the said relay to deënergize, thereby interrupting the circuit for main release relay MRR at alternate contact 61 and establishing an energizing circuit for release relay RR from ground at normal contact 61, normal contact 65, alternate contact 121, through the winding of relay RR to battery, energizing said relay RR. Returning now to relay MRR, upon its deënergization the circuit for relay 73 was interrupted due to the opening of contact 71, allowing said relay 73 to deenergize, opening alternate contacts 66, 75 and 76, thus clearing wipers 24, 25 and 26 from any connection to switch D, so that in the release of wipers they will not effect any busy connections to contacts 27, 28 and 29. Although upon deënergization of relay MRR the locking circuit for relay R of line switch C is interrupted at contact 62, relay R being a slow acting relay maintains its armature in an attracted position until relay RR energizes, thus establishing a new locking circuit for relay R from ground through alternate contact 122. Also, upon energization of relay RR a circuit for release magnet RM is established from ground through alternate contact 123, energizing magnet RM which withdraws the retaining pawls holding wipers 24, 25 and 26 in their adjusted position, and upon withdrawal of the said pawls the wipers are restored to normal by spring tension. The restoration of said wipers first causes the restoration of switch SON and then the restoration of switch PON to normal. The restoration of switch PON interrupts the circuit for relay RR which retracts its armature, interrupting the circuit of release magnet RM and release relay R of line switch C.

Release relay R thereupon deënergizes interrupting the circuit for cutoff relay CO which retracts its armature, and also upon deënergization of relay R a circuit for motor magnet MM is established from ground through alternate contact 56, normal contact 57, normal contact 53 and the winding of magnet MM to alternating current generator, thereby operating magnet MM which steps wipers 15, 16 and 17 forward until they assume a normal position, thereby also restoring off normal switch ON and interrupting the circuit through magnet MM preventing any further advance of the wipers. Line switch C and first selector D having been restored as described are now available for use in establishing other connections.

The release of connector switch E is accomplished as follows: Upon restoration of the receiver of sub-station B to its switch hook, the circuit of relay RC is interrupted allowing the said relay to deënergize, and due to the opening of contact 120, relays TR, 89 and CO′ are restored, all of the said relays having been energized over a circuit including the ground at said contact 120, and upon the opening of contact 101, relay CC has its circuit interrupted and is restored. Upon restoration of said relay CC a circuit for release relay RR′ is established from battery at normal contact 103, alternate contact 105, winding of relay RR′ to ground at alternate contact PON′. Relay RR′ is thereupon energized, opening normal contact 78, thereby interrupting the circuit of relay 77 which deënergizes and upon the closing of contact 106 of relay RR′ a circuit for release magnet RM′ is established, energizing the said magnet which withdraws the retaining pawls for wipers 33, 34 and 35, causing the restoration of switch E. Upon restoration of the wipers 33, 34 and 35, switch PON′ is restored, interrupting the circuit for relays RR′ and 102, allowing the said relays to restore, and upon restoration of relay RR′ release magnet RM′ has its energizing circuit interrupted at contact 106 and it is restored. Switch E and the line of sub-station B having been restored to normal are available for further use in establishing other connections.

*Called line busy.*—Assuming now that the called line is busy, there will be a ground or busy connection upon private contact 30 leading thereto, and upon restoration of secondary relay SR′ after the transmission of the last impulse, there will be no energizing circuit for the upper winding of test relay TR due to the direct ground upon private contact 30 and the ground connection to the other terminals of the upper winding of said relay TR over the before traced path from normal contact 87. Thus relays TR and 89 fail to energize in this case and therefore relay FF is not actuated.

A busy signal is transmitted to the calling subscriber traced from busy back BB, switch SON′, normal contact 107, normal contact 108, back along the lower heavily marked conductor, condenser 109, continuing along the lower heavily marked conductor and then over line limb 10, to receiver of the calling substation, returning over line limb 11, along the upper heavily marked conductor through the left-hand winding of relay PR to ground. The calling subscriber in response to this signal replaces his receiver upon its switch hook, interrupting the circuit for relay PR and thereby causing the restoration of the switches used in establishing the connection. The release of first selector D and line switch C is accomplished as before described and upon deënergization of relay 73 of switch D the ground connection to contacts 27 is removed by the opening of contacts 76, thus allowing relay 77 of connector switch E to deënergize as the relay 102 having failed to energize, alternate

contact 87 in this case was not closed. Therefore, upon deënergization of relay 77 a circuit for release relay RR is established from ground at contact PON′ through the winding of relay RR′, normal contact 105, normal contact 84 to battery. Relay RR′ is thereupon energized and a circuit for release magnet RM′ is established from ground to alternate contact 106, and connector switch E is restored.

Returning now to calling device F. From the foregoing description it will be seen that as all of the impulses have been transmitted and the wipers returned to normal upon their last revolution, that the said calling device F is automatically disconnected and is available for use in establishing other connections.

While I have illustrated but three rows of keys *a*, *e*, *k*, it is apparent that any number of such rows may be connected, depending upon the number of digits or series of impulses in the called number. Even though the calling device F be constructed with five or six rows of keys *k*, *e*, etc., the device is also adapted to transmit a less number of series of impulses than the number of rows included. For instance, in the device F as illustrated, a single series of impulses may be transmitted by simply actuating one of the keys *k*, *m*, etc., in the units row, thereby causing a single revolution only of shaft 37, or if it is desired to send two series of impulses, by actuating a key in the tens row and in the units row, shaft 37 is caused to make two revolutions. It is also apparent that any number of keys *a*, *b*, *c*, etc., may be included in a single row to transmit any number of impulses by simply increasing the number of contacts *aa*, *bb*, etc., and constructing ratchet wheel 38 and impulse wheel 39 accordingly.

*Operation of Fig. 3.*—The operation of calling device G, which is a modification of calling device F, and which may be substituted for the device F, in the operation of the system of Fig. 1, is as follows: In response to the signal L the operator would actuate listening key LK as before and assuming the calling subscriber desires connection with substation 123, as before the operator releases key LK and then throws key K, thereby connecting calling device G with first selector D. The operator then actuates keys *a′*, *f′*, and *n′* to transmit the proper number of impulses as before described. Upon the actuation of the said keys, contacts *p′*, *q′*, *r′*, *s′*, *t′*, *and u′* are moved to their alternate position as before, and a circuit for motor magnet M′ is established from ground through the alternate contacts *p′*, *q′*, and *r′*.

Motor magnet M′ thereupon rotates shaft 37′ and no change is effected until wiper 36′ engages contact *aa′* when a circuit for relay IC′ is established from ground through alternate contact *a′*, contact *aa′*, wiper 36′, ring 40′ and the winding of relay IC′ to battery, energizing the said relay and due to the opening of contact 42′, removes the shunt about impulse springs IS′. At this time the upper contact spring IS′ is resting upon the tip of projection P′, and is out of connection with its fellow spring, thereby interrupting the circuit to relay PR as before described, and upon the next step of magnet M′ the contact springs IS′ are again closed having interrupted the circuit of relay PR a single time. Shaft 37′ is advanced until wiper 36′ engages grounded contact 111, when a circuit for release magnet $MR^3$ is established from the said ground through wiper 36′, contact 111′, alternate contacts *s′*, through the winding of magnet $MR^3$ to battery, energizing said magnet. Magnet M′ then steps wiper 36′ out of engagement with contacts 111, 111′, interrupting the circuit for release magnet $MR^3$ which deënergizes, restoring the actuated keys and springs of the hundreds row.

The operation of the system of Fig. 1 in response to the impulses transmitted from the calling device G, is the same as previously described, so no further reference will be made to the operation of the switches of said Fig. 1.

Although the contact *p′* was restored in response to deënergization of magnet $MR^3$, motor magnet M′ still has an energizing circuit to contacts *q′*, *r′* and continues to advance or rotate shaft 37′ until wiper 36′ engages contact *bb′* which is grounded through key *f′*, thus establishing an energizing circuit for relay IC′, which locks itself to ground at ring 43′, through contact 79′, ring 44′ and wiper 35′, the said relay IC′ removing the shunt about impulse springs IS′ due to the opening of contact 42′. Upon this energization of relay IC′ impulse springs IS′ are opened, as the upper spring is at this time resting upon the tip of projection PP′ and motor magnet M′ continuing to rotate shaft 37′, the said springs IS′ are closed and once more opened and closed, due to the action of projection P′, thus interrupting the circuit through conductors 22′ and 23′ two times. After the last interruption of the circuit through springs IS′ and after they have finally closed their connection, the circuit for relay IC′ is interrupted, as at this time wiper 35′ has moved out of engagement with ring 44′.

Magnet M′ continues to rotate shaft 37′ until wiper 36′ engages contacts 112 and 112′, thus establishing a circuit for release magnet $MR^4$ traced from ground at normal contact *s′*, contact 112, contact 112′, alternate contact *t′* and the winding of magnet

MR⁴ to battery, energizing said magnet which again deënergizes as wiper 36′ is stepped off of contacts 112, 112′, and upon the deenergization of said magnet MR⁴ the switch springs which were actuated in the hundreds row are restored. The rotation of shaft 37′ is continued until wiper 36′ engages contact $cc'$, when a circuit for relay IC′ is established due to the ground upon said contact $cc'$, through the contact of actuated key $n'$ and normal contact $q'$, energizing relay IC′, which establishes a locking circuit for itself through contact 79′ over the previously described path, at the time relay IC′ is energized the upper impulse spring IS′ is resting upon the tip of projection PPP′ thus interrupting the circuit of conductors 22′ and 23′. Magnet M′ continues the advance of the said wipers 35′ and 36′, and upon wiper 35′ moving out of engagement with ring 44′, the energizing circuit for relay IC′ is interrupted, thus again placing a shunt about impulse springs IS′, said springs having interrupted the circuit through conductors 22′ and 23′ three times, during this last said revolution of the device, due to the actions of projections P′, PP′, PPP′. Upon the next step after the last interruption of contacts IS′, wiper 36′ engages contacts 113, 113′ thereby establishing a circuit for release magnet MR⁵ traced from ground at normal contact $t'$, the said contacts 113 and 113′, alternate contact $u'$ and the winding of magnet MR⁵ to battery, energizing the said magnet which again deënergizes upon wiper 36′ moving out of engagement with contact 113 and 113′, thus restoring the actuated contact springs in the units row. Responsive to the operation of magnet MR⁵ a circuit for key magnet KM′ is established from ground through alternate contact 114 and the winding of magnet KM′ to battery, energizing the said magnet KM′ which establishes a locking circuit for itself, traced through alternate contact 115, ring 116, wiper 35′ and grounded ring 43′. Although the initial circuit for magnet M′ through alternate contact $r'$ is interrupted upon restoration of said contact $r'$, a substitute circuit for magnet M′ is established from ground through alternate contact 117 of magnet KM′, and the said magnet M′ continues to rotate shaft 37′ until wiper 35′ is stepped into its normal position thus interrupting the connection across rings 43′ and 116, allowing magnet KM′ to deënergize and interrupt the circuit of magnet M′, preventing any further actuation thereof. Upon the operation of magnet KM′ the actuated key K is restored, thus disconnecting calling device G from the first selector D. Although in calling device G magnets MR³, MR⁴, MR⁵ and KM′ are described as releasing their respective associated switch springs upon deenergization, the restoration of the said switch springs may be effected by the energization of the said magnets.

*Fig. 4.*—The calling device H of Fig. 4 is a modification of the device F and may be substituted for said device F in operating the system of Fig. 1. The rows of keys $a^2$, $e^2$, and $k^2$ with their associated switch springs $p^2$, $q^2$, etc., are arranged similar to the keys of calling devices F and G, the magnets MR⁶ etc. also operating in a similar manner. The rotary switch, which includes wipers 35² and 36² and the associated mechanism, is operated in a different manner, in that the said wipers and impulse wheel 39² make only one revolution in transmitting three series of impulses, or a complete set, while in the calling devices F and G the rotary switch makes a revolution for each series of impulses.

Assuming the operator desires to connect with substation 123, the key K will be actuated as before, thus connecting calling device H to first selector D. The operator then actuates keys $a^2$, $f^2$ and $n^2$, thereby closing a circuit through motor magnet M² from ground through alternate contacts $p^2$, $q^2$ and $r^2$ as before. In response to operation of magnet M², wiper 36² is advanced into engagement with the first contact $jj^2$ and also stepping wiper 35² into engagement with ring 44², while impulse springs IS² have their connection interrupted due to the left-hand spring resting upon the projecting end of the first impulse projection. At this time though, the said springs IS² are shunted by contact 42², and magnet M² continuing to rotate shaft 37², no change is effected until wiper 36² engages contact $aa^2$ which is the first contact having a ground connection, the said ground connection being established through key $a^2$. Responsive to this ground connection a circuit for relay IC² is established through wiper 36², ring 40² and the winding of relay IC² to battery, energizing the said relay and removing the shunt about the springs IS² which are now open due to the engagement with the tip of projection P². The next step of magnet M² moves wiper 36² out of engagement with contact $aa^2$ and wiper 35² out of engagement with ring 44², thus allowing relay IC² to deënergize, again establishing a shunt about impulse springs IS² which are now closed. Thus it will be seen that a single interruption of the circuit including conductors 22² and 23² has been effected, thus operating relay PR a single time as before. The operation of the system of Fig. 1 when controlled by calling device H is the same is previously described and therefore it is believed no further reference is necessary thereto.

Magnet M² continues the rotation of shaft

37² and as before nothing further occurs until wiper 35² engages contact 45′ when a circuit for release magnet MR⁶ is established from the grounded wiper 35², contact 45′, alternate contact $s^2$ and the winding of magnet MR⁶ to battery, energizing the said magnet which maintains its armature attracted until wiper 35² moves out of engagement with contact 45′ and assumes a normal position indicated by dotted line NP′. Upon the interruption of the circuit of magnet MR⁶ as just stated the said magnet deënergizes, restoring the actuated switch springs of the hundreds group. As the alternate contacts $q^2$ and $r^2$ are still closed, magnet M² continues to rotate shaft 37² until wiper 36² engages contact $bb^3$ which is connected to ground through key $f^2$ and normal contact $p^2$. When the said wiper 36² connects to the said contact $bb^3$, a circuit for relay IC² is established from said ground connection, through wiper 36², ring 40² and the winding of relay IC² to battery, energizing the said relay which locks itself through contact 79², to ring 44² and wiper 35² to ground. At this time the impulse springs IS² have their connection open due to the end of said springs resting on the tip of an impulse projection and as relay IC² is energized, the circuit including conductors 22² and 23² is interrupted. Magnet M² continues the advance of shaft 37² until wiper 36² has stepped out of engagement with contact $aa^3$, and wiper 35² out of engagement with ring 44², thus interrupting the circuit through relay IC² and again closing a shunt around impulse springs IS² after they have interrupted the metallic circuit two times. The advance of the wiper is continued until wiper 35² engages contact 45² closing a circuit for release magnet MR⁷ from the ground connection to contact 45², through normal contact $s^2$, alternate contact $t^2$ and the winding of magnet MR⁷ to battery, energizing the said magnet which maintains its armature attracted until wiper 35² is stepped out of engagement with contact 45² and into the position indicated by the dotted lines NP², when the circuit for said magnet MR⁷ is interrupted, deënergizing it and restoring the actuated contact springs of the tens row. Key $n^2$ having been actuated in the units row, shaft 37² is continued in its rotation until wiper 36² engages contact $cc^4$, thereby establishing a circuit for relay IC², traced from ground through normal contact $q^2$, key $n^2$, contact $cc^4$, wiper 36², ring 40², the winding of relay IC² to battery, energizing the said relay and removing the shunt from about the impulse springs IS², whose contact is at this time interrupted by an impulse projection. The advance of shaft 37² is continued until wipers 36² and 35² have passed out of engagement with contact $aa^4$ and ring 44² respectively, which occurs after the third interruption between the impulse contacts IS². As the wipers 36² and 35² move out of engagement with their contacts as stated, relay IC² deënergizes, thus restoring the shunt around impulse springs IS² and preventing further interruptions of the springs having any effect upon the circuit including the conductors 22² and 23² while the wipers 35² and 36² are restoring to normal. The last series of three impulses having been transmitted, the wipers are advanced until contact 45³ is engaged by wiper 35², thereby establishing an energizing circuit for magnets MR⁸ and KM² traced from the said grounded contact 45², normal contact $s^2$, normal contact $t^2$, alternate contact $u^2$ and the windings of said magnet MR⁸ and KM² to battery, said magnets maintaining their armatures attracted until wiper 35² is moved out of engagement with contact 45³ and into its normal position, when the circuit through the said magnets is interrupted allowing them to deënergize, magnet MR⁸ restoring the actuated contact springs of the units row and magnet KM² restoring key springs K. The restoration of contact springs $r^2$ interrupts the circuit through motor magnet M², thus preventing any further advance of the wipers. The calling device H being again at normal is available for further use in establishing other connections.

Although I have illustrated in Fig. 4 a calling device for transmitting three series of impulses it is apparent that as in F and G, by adding more rows of contacts, such as $a^2$, $b^2$, etc. and their associated contacts $p^2$, $s^2$ and adding extra divisions to the rotary switch that any number of digits or series of impulses may be transmitted in a set. The device as illustrated is also adapted to transmit a single series of impulses or two series of impulses. For instance, if it is desired to transmit one series of four impulses, by actuating key $o^2$, the contacts $dd^2$ will be grounded and motor magnet M² rotates shaft 37² as before, until wiper 36² engages the grounded contact $dd^2$, thereby causing an energization of relay IC² and allowing four interruptions of the circuit including conductors 22² and 23². Shaft 37² is continued in its rotation until wiper 35² engages contact 45′, thus closing an energizing circuit through magnets MR⁸ and KM², thereby causing a restoration of the actuated contact springs $o^2$, $r^2$ $u^2$ and preventing any further advance of shaft 37², the wipers being maintained in the position indicated by the dotted line NP′.

Assuming the wipers are in position NP′ and should the operator desire to send two series of impulses, she would actuate a key in the tens row and then in the units row, thereby causing magnet M² to rotate shaft 37² over two groups of impulse controlling contacts and until the wiper 35² has passed

out of engagement with contact $45^3$ and into the normal position as illustrated. From the foregoing description it will be readily seen that one or more series of impulses may be transmitted in a set, according to the number of keys, $a^2$ etc. actuated.

While I have illustrated my invention as operating in connection with a preferred telephone system, it is to be understood that my invention is not limited to any particular system but is applicable to any system in which directive impulses are transmitted for controlling automatic switches, and while I have illustrated my invention with several modifications I do not desire to be limited to the structures as shown, as many modifications and changes may be made without departing from the spirit and scope of the invention.

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

1. A calling device comprising impulse keys and an electromagnetically driven automatic switch for transmitting variable series of impulses, said series corresponding in number to the number of keys actuated.

2. A calling device comprising impulse keys of different digit values, an electromagnetically driven automatic switch for transmitting impulses corresponding in value to said keys, and means for operating said switch to transmit variable series of impulses, said series corresponding in number to the number of keys actuated.

3. A calling device comprising impulse keys, and an automatic switch controlled by said keys for transmitting variable series of impulses, said series corresponding in number to the number of keys actuated.

4. A calling device comprising sets of impulse keys of different digit values, one for each digit in each set, and an automatic switch controlled by said keys for transmitting variable series of impulses, said series corresponding in number to the number of keys actuated.

5. A calling device comprising a keyboard including a plurality of sets of impulse keys, an automatic switch controlled from said keyboard and having a set of contacts common to said sets of keys, a wiper for said switch adapted to coöperate with said contact set for each key actuated, and connections extending from said keys to said switch to cause such actuation of said wiper.

6. A calling device comprising a plurality of sets of impulse keys multiply connected, a set of passive contacts common to said keys and connected thereto, a wiper contact for said contact set, and means controlled by said keys for moving said wiper contact over said contact set once for each key actuated.

7. A calling device including sets of impulse keys, an automatic switch adapted to operate for transmitting impulses corresponding in digit value to said keys, and means for effecting an operation of said switch responsive to actuation of any one of said keys.

8. In a calling device the combination with a plurality of sets of impulse keys, of an automatic switch common to said keys and adapted to operate for transmitting impulses corresponding in digit value to said keys, and means controlled by each key for effecting an operation of said switch for each key actuated.

9. A calling device including a set of manually operated impulse keys, an automatic switch controlled by said keys for transmitting impulses corresponding to the digit value of said keys, and electrically actuated means controlled by said switch for releasing a key when actuated.

10. In a calling device the combination with a plurality of sets of manually operated impulse keys, of an automatic switch adapted to operate for transmitting impulses corresponding in digit value to said keys, means for effecting an operation of said switch responsive to actuation of any one or more of said keys, and means controlled by said switch for restoring the actuated keys.

11. A calling device comprising a plurality of sets of impulse keys, an automatic switch controlled by said keys and adapted to operate for transmitting series of impulses corresponding to the number of sets of keys, means for operating said switch to transmit variable series of impulses according to the number of keys actuated, and means to prevent said switch from transmitting more series of impulses than keys actuated.

12. A calling device comprising a plurality of sets of impulse keys, a progressive switch controlled by said keys and having control contacts and a coöperative wiper adapted to be operated a number of times corresponding to the number of sets of keys, and means for preventing said wiper and contacts from coöperating more times than there are keys actuated.

13. A calling device comprising impulse keys, a progressive switch controlled by said keys and adapted to travel a definite distance responsive to operation of any one of said keys, an impulse wheel and coöperative contacts for said wheel adapted to be operated a definite number of times by each operation of said switch, and means controlled by said keys for rendering said contacts effective according to the digit value of the key actuated.

14. In a calling device the combination with a plurality of sets of manually operated impulse keys having different digit values, of an automatic switch controlled by said keys and adapted to operate for trans-

mitting series of impulses corresponding in digit value to said keys, each key being adapted to control a series of impulses, means for effecting an operation of said switch responsive to actuation of a key in each set, and means controlled by said switch for restoring each key individually after the series of impulses controlled thereby have been transmitted.

15. A calling device comprising a plurality of manually operated members and impulse mechanism operated responsive to actuation of any one or more of said members.

16. A calling device comprising sets of impulse keys, an automatic switch having a set of contacts multiply connected to said sets of keys, a wiper for said switch adapted to coöperate with said contact set, and means controlled by said keys for causing a cooperation of said wiper and contact set for each key actuated.

17. A calling device comprising sets of impulse keys, an automatic switch having a set of contacts multiply connected to said sets of keys, a wiper for said switch adapted to coöperate with said contact set, and means including a starting circuit common to and controlled by said keys for causing a cooperation of said wiper and contact set for each key actuated.

18. A calling device comprising a key board including a plurality of impulse keys, and an electromagnetically driven automatic switch controlled from said key board for transmitting variable series of impulses, said series corresponding in number to the number of keys actuated.

19. A calling device comprising setting members, impulse mechanism connected with said setting members, and means operable by one or more of said setting members for causing operation of said impulse mechanism.

20. A calling device comprising a keyboard including a plurality of impulse keys, an automatic switch for transmitting variable series of impulses, said series corresponding in number to the number of keys actuated, and means controlled by said impulse keys for effecting an operation of the automatic switch for transmitting such impulses.

21. A calling device comprising sets of setting members, normally inoperative impulse mechanism connected with said setting members, and means actuated by the operation of any of said setting members for causing the operation of said impulse mechanism.

22. A calling device comprising impulse keys, a normally passive automatic switch adapted for transmitting variable series of impulses according to the number of keys actuated, and means controlled by said keys for operating said automatic switch.

23. A calling device comprising impulse keys of different digit values, a normally passive automatic switch adapted for transmitting impulses corresponding in value to said keys, and means controlled by said impulse keys for operating said switch to transmit variable series of impulses according to the number of keys actuated.

24. A calling device comprising impulse keys having a normally passive automatic switch controllable by said keys for transmitting variable series of impulses corresponding to the number of the actuated keys.

25. A calling device comprising impulse keys and an electromagnetically driven automatic switch for transmitting variable series of impulses, said series corresponding in number to the number of keys actuated, and automatic means for restoring the said keys.

26. A calling device comprising impulse keys of different digit values, an electromagnetically driven automatic switch for transmitting impulses corresponding in value to said keys, means for operating said switch to transmit variable series of impulses, said series corresponding in number to the number of keys actuated, and automatic means for restoring the said keys.

27. A calling device comprising a key board including a plurality of impulse keys, an electromagnetically driven automatic switch controlled from said key board for transmitting variable series of impulses, said series corresponding in number to the number of keys actuated and automatic means for restoring the said keys.

28. A calling device comprising impulse keys and an electromagnetically driven automatic switch for transmitting variable series of impulses, said series corresponding in number to the number of keys actuated, and electrical connections from said keys to the said switch.

29. A calling device comprising impulse keys of different digit values, an electromagnetically driven automatic switch for transmitting impulses corresponding in value to said keys, means for operating said switch to transmit variable series of impulses, said series corresponding in number to the number of keys actuated, and electrical connections extending from the said keys to the said automatic switch.

30. A calling device comprising impulse keys, an automatic switch controlled by said keys for transmitting variable series of impulses, said series corresponding in number to the number of keys actuated, and electrical connections extending from the keys to the automatic switch.

31. A calling device comprising setting members, impulse mechanism electrically connected with said setting members, and means operable by one or more of said setting members for causing operation of said impulse mechanism.

32. A calling device comprising sets of setting members, normally inoperative impulse mechanism electrically connected with said setting members, and means actuated by the operation of any of said setting members for causing the operation of said impulse mechanism.

33. A calling device comprising impulse keys, a normally passive automatic switch, adapted for transmitting variable series of impulses according to the number of keys actuated, and electromagnetic means controlled by said keys for operating said automatic switch.

34. A calling device comprising impulse keys having a normally passive automatic switch controllable by said keys for transmitting variable series of impulses corresponding to the number of the actuated keys, the said keys being electrically connected with the automatic switch.

Signed by me at Chicago, county of Cook, and State of Illinois, in the presence of two witnesses.

ALFRED H. DYSON.

Witnesses:
M. R. ROCHFORD,
GEORGE E. MUELLER.