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TELEPHONE SYSTEM

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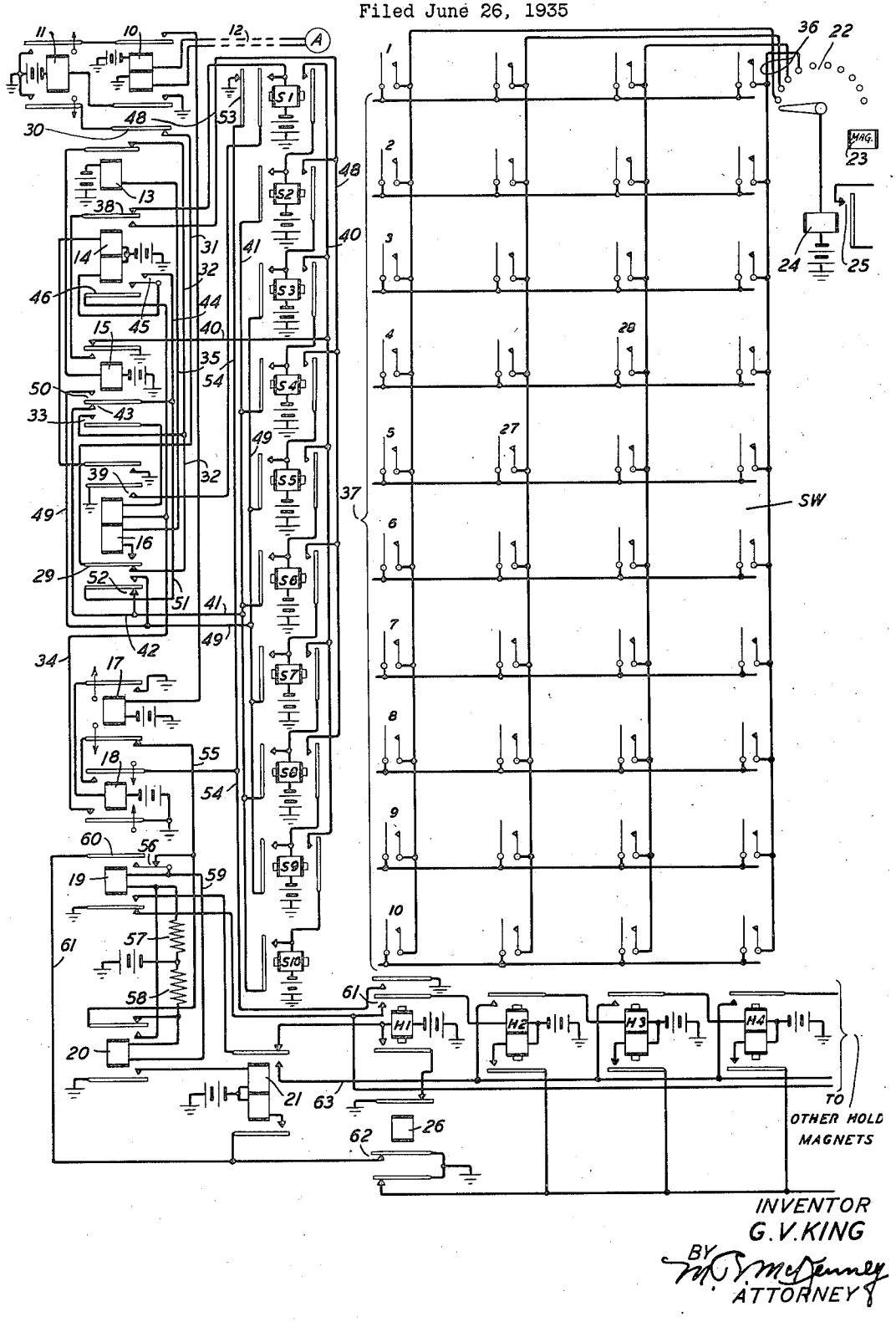

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TELEPHONE SYSTEM

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3 Claims. (Cl. 179—18)

This invention relates to automatic telephone systems and particularly to improvements in registering mechanism for digits.

An object of the invention is to improve and simplify circuit arrangements used in connection with cross-bar switches as registering mechanism.

Heretofore systems have been provided in which cross-bar switches have been used for registering digits. In these systems a digit was registered by the operation of the desired selecting magnet followed by the operation of a holding magnet when the recording on a set of counting relays of a series of impulses representing the digit was completed. Cross-bar switches have also been used as selectors and connectors where, in the case of a selector, the selecting magnets were operated and released by succeeding impulses in the digit dialed until the last impulse in the digit was reached when the corresponding selecting magnet was operated and then maintained operated, while the holding magnets were operated automatically in succession to hunt for an idle trunk. When a switch was used as a connector both the selecting magnets and the holding magnets were controlled by the tens and units digits respectively in the same manner as the selecting magnets were controlled when a switch was used as a selector.

This invention is applicable to a registering system using cross-bar switches. The arrangement for registering digits includes a pulsing relay and a circuit comprising several relays responsive to series of impulses received from the pulsing relay for operating and releasing selecting magnets in succession, one for each impulse, and for locking the selecting magnet operated by the last impulse in each series received and a similar circuit arrangement responsive at the end of each series of impulses for operating and holding operated a succeeding holding magnet and restoring the selecting magnet locked by the corresponding series received. The same type of circuit arrangement is used for the control of both the selecting magnets and the holding magnets and comprises in general two relays for each circuit. In the case of the selecting magnet control the two associated relays are operated for every odd impulse and released for every even impulse, and in the case of the holding magnet control the two associated relays are operated after every odd digit and released after every even digit.

The invention has been illustrated in the accompanying drawing, in which a system is represented as comprising a cross-bar switch SW, used as a register, with its selecting magnets S_1 to S_{10} and holding magnets H_1 to H_4 located immediately to the left and bottom thereof respectively. This system also shows a receiving pulse relay **10** actuated by the subscriber's dialing device in subscriber set A, which for the purpose of this description may be assumed to have been connected over line **12** to pulse relay **10** via a line finder or line switch, not shown, control relays **13** to **16** for operating the selecting magnet in accordance with the digit number dialed, control relays **17** to **21** for operating the holding magnet for each digit dialed, a digit control switch **22** for connecting a sending pulse relay **24** to cross-points on the switch SW in transmitting the recorded subscriber's number and release relay **26** for wiping out the record after it has been transmitted to the connecting switches.

The cross-bar switch SW indicated in the drawing may be that of any mechanism having equivalent selecting and holding magnets for operating contacts in the bank of the switch. More specifically, reference may be had to the Patent 2,021,329 to J. N. Reynolds, of Nov. 19, 1935, in which such a switch is described. For the purposes of this description it has been elected to show a switch having the customary ten rows of contacts high but only four instead of the usual ten rows wide. Also, for simplicity each cross-point is represented by one set of make contact springs but it will be readily understood that other spring combinations could be provided. Normally, all contact springs are unoperated but when one of the holding magnets operates at the time one of the selecting magnets is in an operated condition, then the contact springs at the corresponding cross-point will close and remain closed as long as the holding magnet remains operated, even though the selecting magnet does immediately release. Other contact springs in the same vertical row with the holding magnet, therefore, remain in a normal position and cannot be closed by their corresponding selecting magnets as long as the holding magnet in that row remains operated. This mechanism, as shown, registers four different digits, one on each row of contacts controlled by its corresponding holding magnet in a manner presently to be described.

Assuming now, for example, that a three digit number such as **454** is to be registered, it will be shown how relays **13**, **14**, **15** and **16** function on the dialing of the first digit to cause each of selecting magnets S_1 to S_4 to operate and release in turn for each pulse delivered by relay **10**. On the fourth pulse of the first digit as S_4 selecting magnet operates the holding magnet H_1 operates to lock in an operated position the corresponding contact springs at the cross-point **4** in the first row of bank contacts. It will also be shown how relays **17**, **18**, **19**, **20** and **21** function to control the operating ground for the holding magnets H_1 to H_4. In the example chosen, after the number **4** representing the first digit has been recorded by the operation of hold magnet H_1, the ground circuit is shifted to the magnet H_2

so that when the next digit 5 has been dialed the H_2 magnet will be operated and thus operate contact springs 27 in the second row of bank contacts. The ground circuit is then shifted to the hold magnet H_3 so that it may be operated to function contact springs 28 after the last digit 4 has been dialed. In this manner any number of impulses may be registered on switch SW dependent only on the capacity of the bank to carry the required contact springs.

Upon completion of registration, the register circuit may be made to function in any one of a number of well-known ways to step the control switch 22 with its magnet 23 for successively connecting the sending pulse relay 24 to leads 36 one at a time, thence to interrupter leads 37 depending on the particular set of contact springs in each row that is operated. It will be readily understood that the first one of the interrupter leads 37 at the top of the switch will always be capable of emitting one pulse continuously at intervals, the next lead two pulses and so on to the bottom lead which emits ten pulses. The sending pulse relay 24 will therefore follow the pulses of the lead to which it is connected and under the control (not shown) of the register circuit will function to extend the subscriber's talking connection in any well-known manner through connecting switches, not shown, to a called subscriber station.

When a subscriber calls, the lifting of the telephone receiver from its hook closes the circuit in the usual way through a line relay, not shown, at the central office. If as assumed, the telephone system employs line finders for making connection with a subscriber sender and register circuit, operation of said line relay starts an idle line finder circuit to hunting for and connect the calling line with an idle subscriber sender and sender register circuit. As these equipments are well-known in the art they have not been shown and it will therefore be assumed that when the subscriber starts dialing the number of the wanted party, the pulsing or subscriber's loop circuit is connected as shown in the drawing through leads 12 to the pulse relay 10.

The manner in which the operation of pulse relay 10 is registered on the cross-bar switch SW will now be described. A circuit through the windings of pulse relay 10 to battery and ground is now closed by the subscriber over the subscriber's line causing said relay to operate and in turn operate relay 11 which connects direct ground to the top and bottom armatures of relay 10 and is sufficiently slow in releasing to remain operated during the open intervals of the subscriber's dial. The subscriber upon dialing the first digit 4 of the number 454, for example, causes pulse relay 10 to release and reoperate four times. On its first release ground is applied by the top armature to slow-release relay 17 which operates and remains operated as long as the pulses continue in any digit dialed. Relay 17 in turn operates relay 18, the function of which will later be described. The lower armature 30 of relay 10 on its first release closes a circuit starting from the ground on lower armature and front contact relay 11, armature 30 and back contact relay 10, lead 31, armature 29 and back contact relay 16, lead 32, back contact and armature of relay 13 to battery through relay 15. Relay 15 in operating connects at contact 33 a locking circuit for itself through top winding of relay 16 and ground over lead 34 at bottom front contact relay 18. Current, however, does not flow in this latter circuit until pulse relay 10 reoperates. In the meantime, ground on the top armature relay 15 causes selecting magnet S_1 to operate over a path traced from ground through the top front contact relay 15, armature 38 of relay 14 and its back contact, through winding of S_1 magnet to battery. Operation of selecting magnet S_1 prepares a path at its right front contact for later operating selecting magnet S_2, otherwise it has no function at this time. At the end of the first dial pulse relay 10 reoperates breaking ground at armature 30 to armature 29 of relay 16. This ground path having acted as a shunt on the top winding of relay 16 now allows the latter relay to operate. Relay 16 at its top armature connects ground through the top winding of relay 14 to battery, causing it to operate. Relay 16 at contact 39 supplies a holding ground for selecting magnet S_1 so it will not release when relay 14 operates and breaks the S_1 operating circuit through armature 38 previously traced. Relay 16 at armature 29 also prepares a circuit from battery through relay 13, lower winding relay 16, and armature 29 over lead 31 to bottom back contact of pulse relay 10 which at the moment is operated. Thus at the end of the first of the four pulses in the first digit relays 14, 15 and 16 remain in an operated position and relay 13 in normal position. Selecting magnet S_1 also remains operated.

At the beginning of the second pulse when relay 10 again releases, ground on bottom armature 30 of relay 10 is connected over lead 31 through bottom winding relay 16 which is operated at this time, lead 35 to winding relay 13 to battery. This path continues to hold relay 16 operated and operates relay 13 which opens the circuit for relay 15. Relay 15 releasing, connects ground at its top back contact to lead 40, thence through the right front contact on selecting magnet S_1 to winding and battery on selecting magnet S_2 causing the latter to operate and lock over the left front contact to leads 41 and 42, contact 43 on relay 15, lead 44, contact 45 and armature 46 on relay 14, lead 34, to ground on bottom contact of relay 18. Relay 15 at contact 33 opens the circuit of the top winding of relay 16 but the bottom winding continues to hold this relay operated. Nothing further happens until relay 10 reoperates when it removes ground at its bottom armature 30 from lead 31, armature 29 and bottom winding of relay 16, thereby releasing both relays 13 and 16. Relay 13 at its top break contact and relay 16 at its armature 29 and back contact prepare a path over lead 31 for the next pulse. Release of relay 16 at contact 39 opens locking ground for selecting magnet S_1 causing the latter to release. Removal of ground on top make contact relay 16 opens circuit through top winding relay 14 but the latter does not release until all pulses in the digit have been sent since it is now held operated from battery through its lower winding, contact 45 and armature 46 through lead 34 and ground at front contact relay 18. Release of relay 16 also connects lead 42 to lead 51 at back contact 52 relay 16 so that when on the next pulse relay 15 operates and opens contact 43 the selecting magnet S_2 will remain operated. Thus at the end of the second of the four pulses in the first digit, relay 14 remains operated and relays 13, 15 and 16 remain normal. Selecting magnet S_2 also remains operated.

At the beginning of the third pulse when relay 10 releases, ground on bottom armature 30 and back contact relay 10 is connected over lead 31,

armature 29 and back contact relay 16, lead 32, back contact and armature relay 13 to battery through relay 15. This path is identical with that traced for the first pulse and likewise results in the immediate operation of relay 15 and the later operation of relay 16 after the pulse relay 10 reoperates. Relay 15 operating causes selecting magnet S_3 to operate over a path traced from ground on top armature and front contact relay 15, armature 38 and front contact relay 14, lead 48, right front contact on selecting magnet S_2, winding of selecting magnet S_3 to battery. The left front contact on the magnet S_3 closes a locking path for itself over lead 49, front contact 50 on relay 15, lead 44, contact 45 and armature 46 of relay 14, lead 34 to ground at relay 18. When pulse relay 10 reoperates, the direct ground on lead 31 for holding relay 15 operated is replaced by the ground path through top winding relay 16 which operates as previously described in connection with the first pulse. Relay 16 operating opens back contact 52 which opens the ground path previously traced for holding the selecting magnet S_2. Thus at the end of the third of the four pulses in the first digit relays 14, 15 and 16 remain operated and relay 13 remains normal. Selecting magnet S_3 also remains operated.

At the beginning of the fourth pulse relay 10 releases causing the operation of relay 13 and the release of relay 15 and operation of selecting magnet S_4 and the later release of relays 13 and 16 in a manner identical with that described above for the second pulse. Thus at the end of the fourth pulse, relays 10 and 14 remain operated and relays 13, 15 and 16 normal. Selecting magnet S_4 also remains operated. This being the last pulse in the first number 4 of the three digit number 454, a short interval elapses before the subscriber starts sending the second digit. In this interval relay 17 releases, thereby releasing relay 18. The latter relay, however, is sufficiently slow to release to permit relay 19 to operate over a path traced from ground on back contact and armature 53 of selecting magnet S_1, lead 54, top front contact relay 18, lower armature and back contact relay 17, lead 55, contact 56 and winding of relay 19, resistance 57 to battery. Relay 20 does not operate at this time due to the ground on lead 55 being connected direct to the upper armature and back contact relay 20 to resistance 58 which path is in parallel with the path from lead 55 traced through contact 56 or from ground on armature 60 of relay 19, lead 59, winding relay 20 to the same resistance 58. Relay 19 thus being operated provides a locking circuit for itself on armature 60 over lead 61 from the back contact 62 of relay 26 to ground.

The operation of relay 19 at its lower armature connects ground to the top armature and back contact relay 21, thence through the winding of holding magnet H_1 to battery. Holding magnet H_1 thereupon operates and at its bottom make contact closes a locking circuit for itself to ground on top back contact and armature of relay 26. Contact springs 4 in the bank of crossbar switch SW are thus caused to operate and, as previously described, the operation of other selecting magnets in recording the succeeding digit numbers will not cause any other contacts in the same vertical row for the holding magnet H_1 to operate. Slow relay 18 finally releases and opens ground at the bottom armature from lead 34 thereby causing relay 14 to release followed by the release of selecting magnet S_4 and restoring of this portion of the circuit to normal, preparatory to the dialing of the next digit. Release of relay 18 also opens the ground path over lead 54 so that winding of relay 20 is no longer short-circuited by the circuit through lead 55 and top break contact on relay 20. The latter relay thus operates and both relays 19 and 20 continue to be held by the ground at armature 60 of relay 19 until the end of the next digit is dialed by the subscriber. Relay 20 operates relay 21 which prepares a path for operating succeeding holding magnets H_2 etc. Relay 21 remains operated until the complete number is dialed.

The subscriber on dialing the second digit 5 of the number 454 in the example causes pulsing relay 10 to operate and release five times. On its first release, ground at its top back contact closes the circuit for again operating relay 17 and in turn relay 18, both of which remain operated until the five pulses are sent by the subscriber's dial. The first four out of the five pulses from the dial control pulse relay 10 and associated relays 13 to 16 in the same manner as described above for the first digit 4. At the end of the fourth digit therefore relays 13, 15 and 16 will remain normal with relay 14 and selecting magnet S_4 operated. At the beginning of the fifth pulse relay 10 releases causing the operation of relay 15 and later the operation of relay 16 over the same paths previously traced in connection with the first pulse of the digit 4. Relay 15 operating closes ground at its top make contact to a path traced over armature 38, and front contact of relay 14 to lead 48, thence through right front contact to a selecting magnet S_4 to the winding and battery on selecting magnet S_5. The latter magnet upon operating provides a locking circuit for itself at its left front contact over lead 49, through make contact 50 on relay 15, lead 44, to ground at contact 45 on relay 14. Later, as pulse relay 10 reoperates, relay 16 operates and at its back contact 52 breaks the ground circuit, over lead 5 from relay 14, to lead 41, thereby releasing selecting magnet S_4. The net result, therefore, of the five impulses from the subscriber's dial is to get selecting magnet S_5 in an operated position. At the end of these pulses the relay 17 releases and closes a ground path for causing relay 19 to release. This path is traced from ground on back contact and armature 53 of selecting magnet S_1, over lead 54, top make contact on relay 18, bottom break contact on relay 17, lead 55, through top armature and front contact relay 20 to resistance 57. Since the holding path for relay 19 is also traced from ground on its own top armature 60 front contact and winding to the same resistance 57, it will be evident that the first path traced from direct ground will shunt out the ground path through the winding of relay 19, thereby causing its release. Relay 19 in releasing at contact 56 transfers the holding of relay 20 to lead 55. Relay 19 also closes a circuit for operating holding magnet H_2 over a path traced from ground on its bottom armature and back contact through contact 61 on holding magnet H_1 and thence through the top winding on holding magnet H_2 to battery. When the slow releasing relay 18 releases it opens the ground path through break contact on relay 17 and the lead 55 causing relay 20 also to release and prepare the circuit control of relays 19 and 20 for the next digit. Release of relay 18 at its bottom contact also removes ground from lead 34, causing selecting magnet control relays 14 to 16 to restore to normal for use in

recording the next digit. Selecting magnet S_5 then releases. When holding magnet H_2 operated it caused the contact springs **27** in the bank of the switch SW to operate, due to the selecting magnet S_5 being in an operated position at that time. The holding magnet H_2 locks through its bottom winding and bottom make contact to ground on relay **26** and remains operated until after the registered number is no longer required.

The subscriber upon dialing the last digit **4** of the number **454** again causes relay **10** to follow the contact closure of the dial and it may be assumed that relays **13** to **16** function in identically the same manner as described above for the first digit of the number. At the end of these four pulses of the relay **10**, relay **17** releases again and closes a circuit from ground at contact and armature on selecting magnet S_1, lead **54**, top make contact relay **18**, top break contact relay **17**, lead **55**, contact **56** and winding on relay **19**, through resistance **57** to battery. Relay **19** operating closes ground at its bottom make contact through top armature and front contact relay **21**, over lead **63**, through top make contact on holding magnet H_2 to top winding H_3 to battery. When slow-release relay **18** releases it opens the ground path at its top make contact as described above for permitting relay **20** to operate and at its bottom contact it opens the circuit previously described for restoring the selecting magnet control relay **13** to **16** to normal. The holding magnet H_3 through its bottom winding and bottom make contact remains locked to the bottom break contact on relay **26** previously described.

Having thus described the registering of a three digit number **454** it can be seen that numbers with any other number of digits may likewise be registered. Usually, a cross-bar switch of ten digit capacity is employed in order to provide for additional digits to the normal subscriber number which indicate party numbers and the like. When the subscriber sender proceeds to set up the connecting switches guided by the number registered on the cross-bar switch, the sending switch **22** will be made to take one step at a time by control of the magnet **23**. This switch connects the sending pulse relay **24** from battery to the leads designated **36** one at a time. When connected to the first row of contacts the sending pulse relay **24** will be operated by four ground impulses being impressed on one of the leads **37** connected to the armature of contact springs **4** in the first row of contacts. When connected to the second row at contact **27**, pulse relay **24** will be operated by five ground impulses and again when connected to the third row at contact **28** it will be operated by four pulses. Each different one of the leads **37** supplies a different number of ground impulses corresponding to the contact springs to which they are connected. The sending pulse relay **24** thus repeats the number registered on the switch by opening and closing the contact **25** which may be made to control connecting switches in any well-known manner.

When the registered number is no longer required the register equipment will be restored to normal by the sender causing the operation of release relay **26**. This relay at its top and bottom back contacts opens the locking circuit for all holding magnets H_1, H_2 etc. causing them and their associated contact springs to restore to normal. At contact **62** on relay **26** ground is removed from lead **61** for restoring relays **19**, **20** and **21**. Upon the further disconnection of the sender from the line finder the circuit to the pulse relay **10** will have been broken allowing the relay **19** to release and thereafter to release slow relay **11** and restoring the register circuit completely to normal.

What is claimed is:

1. In a telephone system, a cross-bar switch comprising selecting magnets and holding magnets and means responsive to the operation of a selecting magnet followed by the operation of a holding magnet for establishing a corresponding connection in said switch, a pulsing relay, means responsive to a series of impulses from said relay for operating and releasing said selecting magnets in succession, one by each impulse and for locking the selecting magnets operated by the last impulse in each series received, and means responsive at the end of each series of impulses for operating and holding operated the succeeding holding magnet and for releasing the selecting magnet locked by the corresponding series received.

2. In a telephone system, a cross-bar switch comprising contacts arranged in horizontal and vertical rows, two sets of lines, each line of one set connected to contacts in a corresponding horizontal row, and each line of the other set connected to contacts in a corresponding vertical row, a selecting magnet for each horizontal row, a holding magnet for each vertical row, means effective on the operation of a selecting magnet followed by the operation of a holding magnet for establishing a connection at the contacts at the intersecting point between corresponding lines, a pulsing relay, sets of relays and circuit means responsive to series of impulses from said pulsing relay for operating and releasing said selecting magnets in succession, one by each impulse and for maintaining the selecting magnet operated by the last impulse received in each series, a second set of relays and circuit means responsive at the end of each series of impulses for operating and holding operated a succeeding holding magnet and release the selecting magnet locked by the corresponding series received.

3. In a telephone system, a cross-bar switch comprising selecting magnets and holding magnets and means responsive to the operation of a selecting magnet followed by the operation of a holding magnet for establishing a corresponding connection in said switch, a pulsing relay, means including two relays responsive to a series of impulses to operate on every odd impulse and releasing on every even impulse of said series, means responsive on the succeeding alternate operations of said relays for operating and releasing succeeding selecting magnets and locking the last selecting magnet operated on the last operation or release of said relays in response to the last impulse received, means including a third relay operative to actuate said third relay when the first impulse is received in said series and operated to release said third relay when the last impulse has been received, means including a fourth and fifth relay operative to actuate said fourth and fifth relay on the release of said third relay at the end of each odd series and to release said fourth and fifth relay on the release of said third relay at the end of each even series, and means operating in response to the operation or release of said fourth and fifth relays for operating and holding operated succeeding holding magnets and for releasing the selecting magnets locked by the corresponding series.

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