June 4, 1946. R. E. PIERCE ET AL 2,401,507

SECRECY CIPHER SYSTEM

Filed Aug. 25, 1942 2 Sheets-Sheet 1

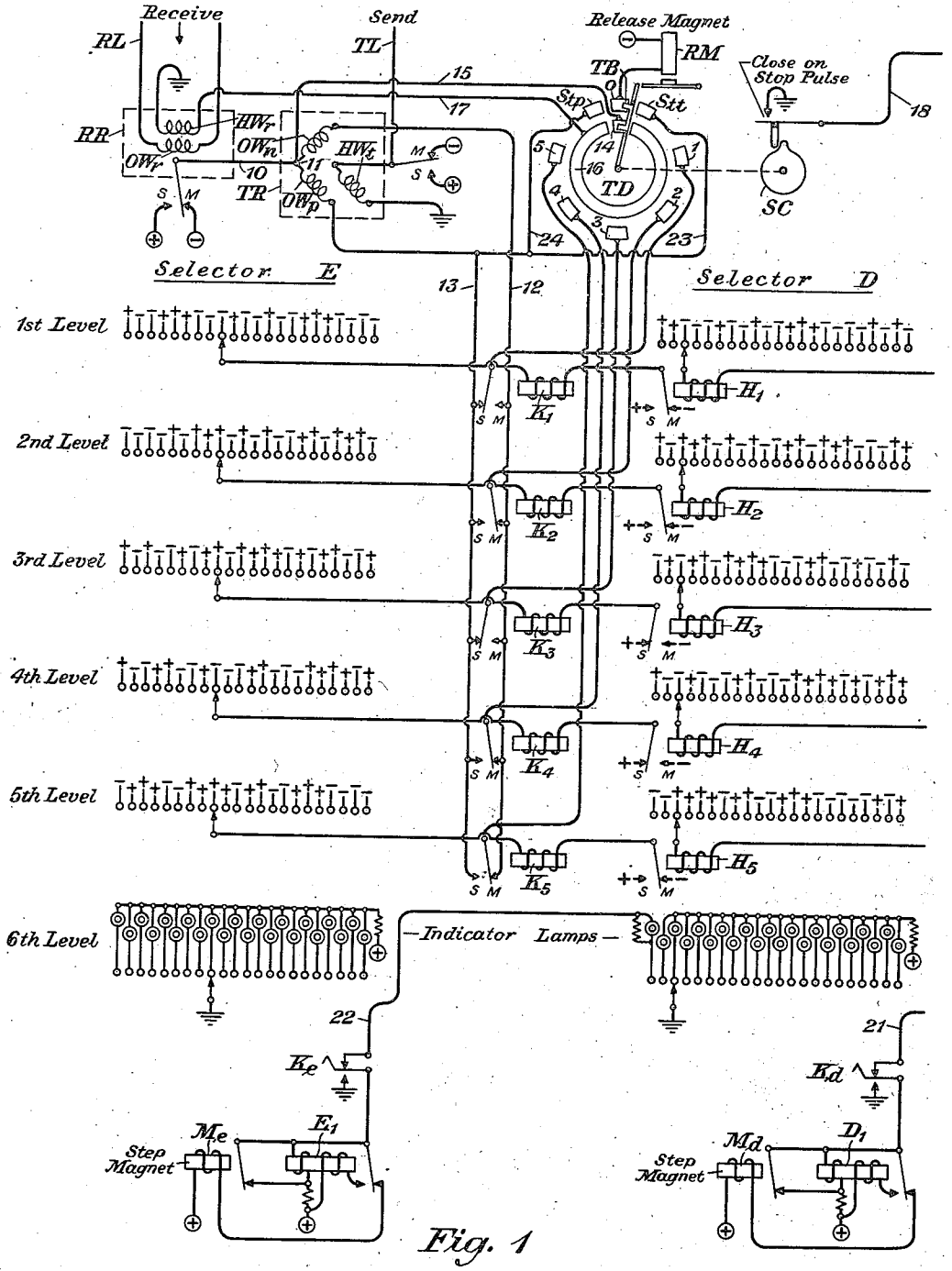


Fig. 1

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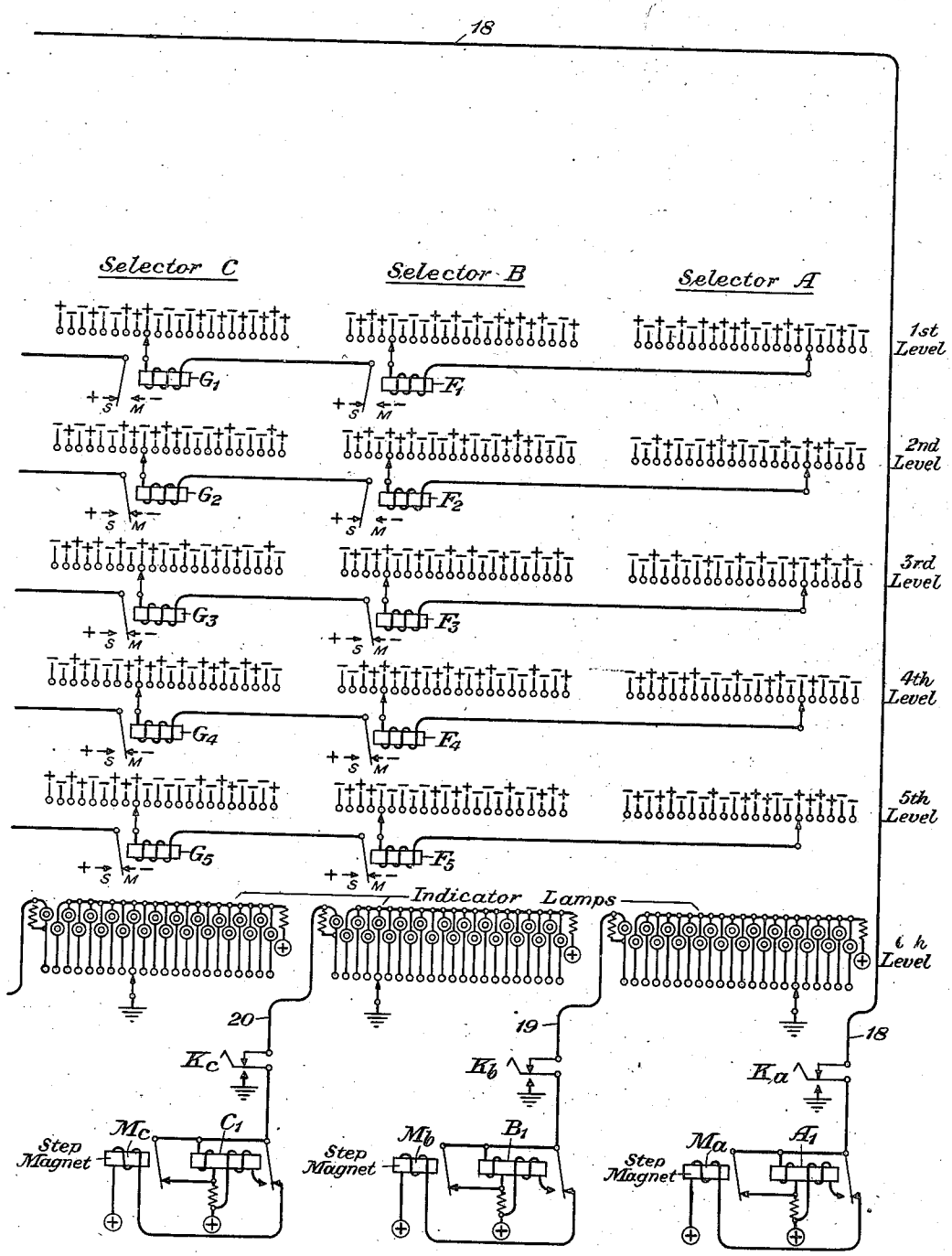


Fig. 2

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SECRECY CIPHER SYSTEM

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20 Claims. (Cl. 178—22)

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This invention relates to secrecy cipher systems, and more particularly to such systems designed for use in connection with teletypewriter systems employing the Baudot code.

Heretofore it has been proposed to encipher the characters of a teletypewriter message by combining the successive characters of a message with successive characters of a key consisting of an endless series of characters arranged in an arbitrary and random manner. The Baudot code pulses sent out for each message character will then be a resultant of the Baudot pulses representing the key character superposed on those representing the character to be transmitted.

Ordinarily each character is represented by five Baudot impulses which may be either marking or spacing, and the identity of the character is determined by the successive arrangement of the pulses as to their marking or spacing condition. If a pulse of a message character to be transmitted is marking and the corresponding pulse of the key character is also marking, then a marking pulse will be sent out. If both pulses are spacing, a marking impulse will be sent. If, however, one impulse is marking and the other spacing, then regardless of which is which, a spacing impulse will be sent out.

If, as has been heretofore proposed, the key pulses are derived from a random succession of enciphering characters recorded on a teletypewriter tape of such length that all of the messages ever sent would not use all of the enciphering characters so recorded, each message sent out would be scrambled to such extent that it would be impossible to decipher it without knowing what key characters were employed and in what order. If the key characters were arranged in an absolutely random manner, there would be no way of predicting when a given character would be repeated, and no way to determine in what succession the key characters followed each other. With a message enciphered in this manner it would be impossible to "break" the code. At the receiving machine an identical key is provided which combines with the scrambled signals on the line to return the message to plain text.

As a practical matter, however, the ideal conditions for complete security mentioned in the preceding paragraph may not always be necessary or desirable. To meet these conditions it is necessary to have at each end of each circuit duplicate random keys with as many characters as there are in all of the plain text messages to be transmitted. Consequently it is desirable to use compromise measures involving simpler arrangements. In view of the difficult problems involved, recourse has been had in the past to the expedient of using a key tape in the form of an endless belt of considerable length, so that the succession of key characters is not repeated until a considerable interval has elapsed. In order to lengthen the interval during which no repetition of the arrangement of the scrambling characters will occur, it has been proposed to use two endless key tapes, each with a different successive arrangement of characters, and each having recorded thereon a different number of characters. Each character on one tape is combined with a character upon the other tape, and the resultant set of Baudot impulses is used to encipher the Baudot impulses of the actual message character to be transmitted. Since the number of characters on each tape is different, a repetition will not occur when all of the characters on one tape have been transmitted and it starts again with the first character in the series. This is for the reason that the first character will now be combined with a different character on the second tape from that with which it was previously combined. Therefore, no repetition will occur until a number of characters have been transmitted which is a product of the numbers of characters on the two tapes.

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Whether the enciphering system is one using a single tape or one using two tapes combined, the teletypewriter at the receiving station is so arranged that it combines the enciphered message transmitted by the sending station with enciphering characters recorded upon tapes exactly like those used at the transmitting station. Each set of the resultant Baudot code impulses will correspond to that representing the original character of the message transmitted.

In combining two Baudot codes one with another, various methods may be used. The method most commonly used is that previously referred to, in which two like impulses combine to produce a marking pulse, and two unlike impulses produce a spacing pulse. For example, if the character desired to be transmitted is represented by the code combination mark-mark-space-mark-space, and this character is enciphered at the transmitter by being combined with a key character represented by the code combination space-mark-space-mark-mark, the enciphered character actually transmitted will be that represented by space-mark-mark-mark-space. When this combination is combined at the receiving station with the enciphering character space-mark-space-mark-mark, the re-

sultant character printed at the receiving station will be that represented by mark-mark-space-mark-space, which, it will be observed, is the original message character. Anyone tapping the line, however, will get the character represented by space-mark-space-mark-mark.

With an enciphering or deciphering arrangement employing either a single key tape or two combined key tapes, it is desirable to change the setting of the tapes before an actual repetition of the order of characters occurs. This may be done by the parties at the transmitting and receiving stations having a previous understanding as to the points in the key tapes at which messages will start from time to time. A different starting point in the key tape may be used for each message, or the tapes may be reset to start at a new point after a certain amount of time has elapsed. If the new settings are agreed upon in advance, it would be very difficult for an unauthorized person to break the cipher. When the messages are transmitted more or less continuously, day in and day out over a long period of time, it is practically impossible to agree in advance upon the settings. Therefore, it becomes necessary for one station to advise the other as to the point at which the enciphering tapes are to be reset before each change in setting occurs. This information would, of course, be sent in cipher form. Hence there is little or no likelihood that it would furnish a clue which could be used in an attempt to break the cipher.

These resettings of the tapes at the transmitting and receiving stations necessarily occur frequently, and it is very difficult and cumbersome to reset a tape. Consequently, it is desirable to provide some method of producing enciphering combinations which will readily permit resetting the enciphering apparatus to start the series of key characters at a new point. In accordance with the present invention, therefore, it is proposed to use a series of selector switches instead of one or more tapes to provide the enciphering code combinations.

Specifically a step-by-step selector switch having a large number of contacts on each of its banks is used in lieu of a tape. In the case herein illustrated the number of contacts on each bank is twenty-two, but it may be a larger or smaller number as desired. Six banks of contacts altogether are provided for each switch, five being used to produce the elements of the Baudot code (of which there are five for each key character), while the sixth bank is used for indicating purposes, as will be described later.

Each one of the five banks of each switch or selector is used to determine one of the five impulses of the Baudot code combination. Each of the contacts in a given bank is activated in one of two ways corresponding to marking or spacing. For example, each contact may be activated either by a connection to a positive source or by a connection to a negative source. If preferred, some of the contacts may be connected to a source of any polarity, and the others may be made dead or idle contacts. Still another possibility would be to ground some contacts and connect others to battery. The contacts in each bank are in any event activated in a purely random manner in one or the other of the two possible ways provided by the plan.

If only one switch were employed to form the enciphering code combinations, the combination of its wipers to corresponding contacts in the five banks would determine the five pulses

of the enciphering code. After each code combination has been transmitted, the wipers of the switch would then be moved to the next contact on each bank to produce a new enciphering code, etc. A switch thus arranged would be equivalent to an endless tape having a number of characters recorded upon it equal to the number of positions of the switch.

Inasmuch, however, as each switch bank has only a limited number of contacts (in the case assumed twenty-two), it is desirable to employ a series of switches each having five banks of contacts, so that the resultant code combination will be determined by the combined action of all of the switches. In such case the setting of the first and second switches in the series at any given time may be used to determine a set of five Baudot code units. These units in combination with the setting of a third switch may in turn produce another set of five Baudot code units. This second set of Baudot code units might, when combined with the setting of a fourth switch, produce a third set of Baudot code units, which in turn combine with the setting of a fifth switch to determine a fourth combination of Baudot code units, and so on for any desired number of switches. Various other ways may be devised for using circuits extending from switch to switch, or controlled by a series of switches, to determine Baudot code combinations for enciphering purposes. In any case the set of Baudot code units so produced may then be used to scramble the character to be transmitted, after which a new code combination may be produced by advancing one or more of the switches to its next step.

If, for example, the first switch is stepped to a new setting after each code combination has been transmitted, and the second switch is arranged to take one step each time the first switch has stepped through a complete rotation, the Baudot code combinations set-up on the five banks of the first switch will, after each has been combined with a code combination determined by the second switch, be combined with a different Baudot code combination set up by the second switch after it moves to a new position. This will occur each time the second switch is advanced one step by the first switch making a complete revolution.

The second switch may in turn be arranged so that when it completes one rotation it will cause the succeeding switch to advance one step. The succeeding switch may be arranged so that when it completes one rotation it will advance the next switch one step, and so on for all of the switches. By such an arrangement five switches, each having five banks of twenty-two contacts, is capable of producing as many as 5,153,632 Baudot code combinations before a similar sequence or repetition in the ciphering key reoccurs.

The use of step-by-step switches in the matter above described has a great advantage over the use of perforated tapes, in that the switches may be arranged to be stepped manually by the operation of keys to any desired setting when it is desired to start enciphering from a new setting. An arrangement of switches such as above described also has the advantage that, if each switch is provided with an additional bank of contacts and a lamp is connected to each contact thereof, the setting of each switch will be visually indicated by the lamp that is lighted when its wiper rests upon a particular contact.

Further details will be clear from a detailed description of the invention when read in connec-

tion with the accompanying drawings, Figures 1 (*a*) and 1 (*b*) of which illustrate the preferred embodiment of the invention.

In the drawings RL is a receiving circuit upon which the characters to be enciphered or deciphered are impressed. This circuit terminates in a winding OW_r of a receiving relay RR. Normally, when no message code combination is being received, a marking signal (which may be a closed circuit impulse) passes into the circuit RL and holds the armature of the relay RR against its marking contact, so that negative battery is connected to conductor 10. When a space signal is received the armature is shifted to its space contact and positive battery is connected to the conductor 10.

The characters, after being enciphered or deciphered in a manner to be described later, are transmitted to a distant station or a local teletypewriter over a circuit TL by means of a transmitting relay TR, which may include two operating windings OW_n and OW_p, and a holding winding HW_t. The conductor 10, which is controlled by the receiving relay RR, is connected to the junction point 11 of said operating windings, and the other terminals of said windings connected to conductors 12 and 13, respectively, upon which the key pulses are applied, as will appear hereinafter.

In order to properly time the superposition of the character impulses with the key impulses, and to properly time the transmission of the combined code impulses to the transmitting circuit TL, a distributor TD is provided. This distributor is of the general type employed in regenerative telegraph repeaters, and has a rotating brush TB which rotates over two segmental rings. The outer ring includes eight segments, a normal segment 0 upon which the brush rests when it is not rotating, a start segment S_{tt}, code segments 1, 2, 3, 4 and 5, and a stop segment S_{tp}. The inner ring consists of a small segment 14, connected over conductor 15 to the conductor 10, and a large segment 16 connected by conductor 17 to the holding winding HW_r of the receiving relay RR. The purpose of the winding HW_r will be pointed out later. The distributor is of the start-stop type, and is released by means of a release magnet RM in response to the start impulse received from the circuit RL.

The key is produced by means of a series of selectors or switches A, B, C, D and E. Each selector has six levels or banks of segments or contacts, herein shown as twenty-two in number for each bank of each switch. The first, second, third, fourth and fifth levels of the switch are used to formulate the key code combinations, and the sixth level is used to control lamps for indicating the positions in the switches, as will appear more clearly hereinafter. Each selector has a wiper for each bank of contacts, and the contacts of banks or levels 1 to 5, inclusive, are connected either to positive or negative battery in an arbitrary and random order.

The five brushes of selector A are connected to the brushes of selector B through relays F_1, F_2, F_3, F_4 and F_5, respectively. The armatures of said relays are connected through relays G_1, G_2, G_3, G_4 and G_5, respectively, to the brushes of selector C. The armatures of this second set of relays are in turn respectively connected through the windings of relays H_1 to H_5, inclusive, to the brushes of selector D, and the armatures of the last-mentioned relays are similarly connected to the brushes of selector E through the windings of relays K_1 to K_5, inclusive.

Each armature of each relay of the sets F, G and H is, when attracted, connected to negative battery, and when released is connected to positive battery. The armatures of the set of relays K_1 to K_5, inclusive, when attracted, are connected over their front contacts to conductor 12, when released, are connected over their back contacts to conductor 13. These conductors, it will be recalled, are connected, respectively, to the windings OW_n and OW_p of the transmitting relay TL.

The brushes of the several switches may be advanced step-by-step by means of stepping magnets M_a, M_b, M_c, M_d and M_e, respectively. Each stepping magnet has associated therewith a locking relay, the relay A_1 being associated with the stepping magnet M_b, the locking magnet B_1 being associated with the stepping magnet M_c, etc. A stepping cam SC associated with the distributor TD is arranged to close a contact at the time the stop impulse is being transmitted, as will be described later. This contact completes a circuit for the stepping magnet M_a to advance the wipers of the selector A one step after each code combination has been transmitted. The operation of each of the stepping magnets of the other switches is controlled by the preceding switch, as will appear later.

Each of the selectors is provided with a sixth level of contacts equal in number to those of the other levels. In the case of selectors A, B, C and D, each of these contacts except the last one is connected through a lamp to battery, so that when the wipers of the switches are resting upon a particular contact, the lamp corresponding to that contact in the sixth level will be lighted. The last contact in the sixth level of each of these four switches is connected to a circuit which operates the stepping magnet and the associated locking relay of the succeeding switch. A lamp is also included in the circuit of the last contact of the sixth level of each of these switches, to indicate that the switch is in the position corresponding to said contact. In the case of selector E, the last contact of the sixth level is connected through a lamp to battery just as are the other contacts of that level, and no stepping circuit is associated with said last contact for there is no succeeding switch to be operated.

With this arrangement of stepping circuits, selector A is advanced after each character has been transmitted by the closing of the circuit over conductor 18 which controls the stepping magnet M_a. When the selector A is advanced to its twenty-second step, a circuit is completed over conductor 19 for the stepping magnet M_b of the selector B. Selector B, therefore, is advanced one step for each rotation of selector A. When selector B has been advanced to its last contact, a circuit is likewise completed over conductor 20 for the stepping magnet M_c of the selector C, which in turn is advanced one step for each rotation of selector B. In a similar manner the last contact of the sixth level of selector C controls the stepping of selector D, and the last contact of the lower level of selector D in turn controls the stepping of selector E.

An important feature of the invention is the provision of the keys K_a, K_b, K_c, K_d and K_e, which are associated with conductors 18, 19, 20, 21 and 22. By means of these keys each selector may be advanced manually step-by-step to any desired position. The operator is, therefore, able at any time to reset any and all switches to new

positions to start a new succession of key code combinations.

Further details of the invention will be evident from a description of the operation which is as follows: Referring to the receiving circuit RL, this circuit may receive either code combinations corresponding to plain text message characters locally produced, or enciphered characters sent from a distant station. The receiving relay RR received these code combinations, and by transmitting them through the windings OW_n or OW_p of transmitting relay TR, causes them to be combined with the key determined by the setting of the selectors A to E, inclusive, as will appear later. If the received characters are message characters in plain text form, they will then be transmitted to the line TL enciphered. If, on the other hand, the receiving circuit RL is receiving characters already enciphered at a distant station, they will be combined with the proper key combinations set up by the selectors A to E inclusive to produce in the transmitting circuit TL deciphered characters corresponding to the original plain text message characters.

When no code combination is being received, the circuit RL receives a continuous marking impulse corresponding to the stop signal transmitted after each code combination. Each code combination consists of a start impulse, which is always a spacing impulse, followed by five Baudot code impulses representing the character to be transmitted. The fifth Baudot code impulse is in turn followed by a stopping pulse, which as already stated, is always a marking pulse and acts to hold the armature of receiving relay RR against its marking contact. The five impulses of the Baudot code may be either marking or spacing impulses, depending upon the characters which they represent.

Upon receiving a start signal in the form of a spacing impulse, the winding OW_r of receiving relay RR shifts the armature of said relay from marking to spacing, and plus battery is thereby connected over conductor **10** to point **11**, and thence over conductor **15** to segment 14 of the inner ring of distributor TD. From this point the circuit continues over the brush TB of the distributor, over segment 0 of the outer ring of the distributor, and through the release magnet RM to negative battery. The release magnet is accordingly operated and releases the brush arm of the distributor, so that the brush TB passes from segment 0 to the start segment S_{tt}.

At this time the start impulse is still being received by the relay RR and a circuit is completed from positive battery, over the spacing contact of relay RR, over conductor **10**, through the operating winding OW_p of the transmitting relay TR, over conductor **23**, stop segment S_{tt} and brush TB to the long segment **16** of the inner ring, thence over conductor **17** and through holding winding HW_r of receiving relay RR to ground. Current now flows in the holding winding of the receiving relay RR in such a direction as to hold the armature against its spacing contact so long as the brush in the distributor remains on the start segment S_{tt}. The operating winding OW_p of the transmitting relay TL is energized over the circuit above described and operates to shift the armature of the transmitting relay TL from its marking to its spacing contact, so that plus battery is connected to the transmitting circuit TL to send a start signal to the distant station.

The transmitting relay TR is provided with a holding winding HW_t connected between ground and the armature of said relay, so that said winding receives current in a direction tending to hold the armature of relay TR upon the contact to which it was last moved until an impulse is received to shift it to the opposite contact. The holding winding HW_r of the relay RR, on the other hand, functions to hold the armature of the latter relay upon the contact to which it has been operated, until after the brush of the distributor moves off the contact of the outer ring of the distributor corresponding to the impulse being received. This prevents any possibility of the succeeding impulse shifting the armature of the receiving relay RR to its opposite contact before the corresponding impulse has been transmitted to line LL, since the receiving winding OW_r of the receiving relay RR produces a weaker pull upon the armature than that caused by the holding winding HW_r.

After the brush moves away from the start segment S_{tt}, the holding winding HW_r is released and the brush passes to segment number **1**. In the meantime the first impulse of the Baudot code is being received in the operating winding OW_r of the receiving relay RR. If this happens to be a marking impulse, negative battery will be connected to conductor **11**. While this pulse is being received, the brush of the distributor TD passes over segment number **1** of the outer ring of the distributor and the scrambling operation takes place in a manner appearing presently. By this operation the first impulse of the Baudot code combination will have superposed thereon an impulse determined by the setting of the selectors A, B, C, D and E, and specifically this superposed key impulse is determined by the first level of contacts and the corresponding brushes of said selectors.

Let it be assumed that the selectors are in the positions shown in the drawings, i. e. the brushes of selector A upon the 6th segment, the brushes of selector B upon the 18th segment, the brushes of selector C upon the 14th segment, the brushes of selector D upon the 20th segment and the brushes of selector E upon the 14th segment. It will be evident that the relay F_1 is not operated since both of its terminals are connected to negative battery over the 6th contact of selector A, and the 18th contact of selector B, respectively. The armature of relay F_1 will, therefore, rest upon its back contact.

It will also be evident that relay G_1 is not operated, as plus battery is connected to the back contact of relay F_1 and the brush of selector C rests on a contact connected to positive battery. Relay H_1, however, will be actuated because one terminal is connected to the positive back contact of relay G_1 and the other terminal is connected to the negative 20th segment of selector D. The last relay of the series, relay K_1, is not operated since one terminal of its winding is connected to the negative front contact of relay H_1, and its other terminal is connected over the brush of selector F to the negative 14th segment in the first level of said selector. The armature of relay K_1 will, therefore, rest upon its back contact which is connected to conductor **13**.

Assuming a marking signal is being received by receiving relay RR, a circuit is completed from negative battery over the marking contact of relay RR, over conductor **10**, through operating winding OW_p of the transmitting relay TR, over conductor **13**, back contact of relay K_1 to segment number **1** of the distributor TD. Thence the circuit continues over the brush of the distributor

and the long segment 16, over conductor 17, and through the holding winding HW_r of the receiving relay RR. Relay RR, therefore, holds its armature upon its marking contact so long as the brush of the distributor is passing over segment number 1.

It will be noted that there are two controls over the circuit above traced, one exercised by the receiving relay RR and the other by the relay K_1. In the case assumed the first of these controls corresponds to a marking impulse, but the control by the relay K_1 corresponds to a spacing impulse. This will result in transmitting a spacing impulse to line TL because current is transmitted through the operating winding OW_p in such a direction as to shift its armature to its plus or spacing contact. If, however, the pulse received by the relay RR had been a spacing pulse, the armature of the relay RR would have been connected to positive battery and both controls would have been spacing controls. Current would then flow through the operating winding OW_p in the opposite direction. This would result in shifting the armature of the relay TR to its negative or marking contact and a marking signal would be sent to the line.

As soon as the brush passes off segment number 1 of the distributor, the second impulse of the Baudot code may be received as holding winding HW_r is deenergized. Assuming that this pulse is a marking impulse, the armature of relay RR will assume its marking position and negative battery will be applied to the conductor 10. The nature of the pulse to be transmitted to the outgoing circuit TL, however, will be determined by the circuits controlled by the brushes of the second level of selectors A to E, inclusive.

If we trace through the circuits controlled by these brushes, it will be seen that relay F_2 is not operated as positive battery is connected to both terminals of its winding. Relay G_2 is operated as one of its windings is connected to positive battery over the contact of relay F_2, and the other terminal is connected to negative battery over the wiper of selector C. Relay H_2 is also operated, being connected to negative battery over the contact of relay G_2 and to positive battery over the wiper of selector D. Finally, relay K_2 is operated, one of its terminals being connected to negative battery over the contact of relay H_2, and the other terminal being connected to positive battery over the second level brush of selector E. The armature of relay K_2 is, therefore, held against its front or marking contact.

A circuit for the operating winding OW_n may now be traced as follows: From negative battery over the marking contact of relay RR, over conductor 10, through the winding OW_n of relay TR, over conductor 12, front contact of relay K_2, second contact of distributor TD, over the brush of the distributor to the long segment 16 of the inner ring of the distributor, thence over conductor 17, and through the holding winding HW_r to ground. This current will pass through the winding HW_r in such a direction as to hold the contact of the receiving relay RR against its negative or marking contact so long as the brush in the distributor rests upon segment number 2. This prevents the succeeding received impulse, if in the opposite direction, from shifting the armature of the receiving relay to spacing until the distributor has completed the transmission of the resulting impulse to the sending circuit TL. The current flow through the winding OW_n is in such a direction as to activate the armature of the sending relay toward its negative or marking contact and a marking impulse is sent to the line.

If, however, the received impulse had been a spacing impulse, positive battery would have been connected to the operating winding OW_n, and current would have flown through this winding in the opposite direction. Hence the controls exercised by relays RR and K_2 would have been spacing in the former instance and marking in the latter instance. This would result in shifting the armature of the transmitting relay TR to its positive or spacing contact. The current through the holding HW_r of the receiving relay RR would also be reversed and would, therefore, hold the armature of the receiving relay RR upon its spacing contact so long as the brush of the distributor is upon its contact number 2.

As the brush of the distributor TD leaves contact number 2, the holding winding HW_r of the receiving relay RR is deenergized, and relay RR is now free to respond to the third impulse of the Baudot code received from circuit RL. If we examine the circuit conditions in the third level of the series of switches, it will be evident that relays F_3 and G_3 are energized, but that relay H is deenergized. Since the brush of selector E is on the positive contact of the third level, the relay K_3 is connected to positive battery at both its terminals and is deenergized.

With this condition existing, if the third impulse of the Baudot code received from circuit RL is a marking impulse, a circuit will be completed when the brush of the distributor reaches the segment 3, from negative battery, over conductor 10, through operating winding OW_p of relay TR, over conductor 13, back contact of relay K_3, third segment of the outer ring of the distributor TD, over the brush to the long inner segment 16 of the distributor, and thence over conductor 17, through the holding winding HW_r of the receiving relay RR to ground. The current flowing through the winding HW_r is in such a direction to hold the armature of relay RR against its marking contact. Since the relay RR is in marking condition due to the third received impulse, and since the relay K_3, which records the enciphering condition for this impulse, is in spacing condition, the current flows through the winding OW_p in such a direction as to impel the armature of the relay TR to its spacing contact so that a positive pulse is sent out to the line TL.

It will, of course, be evident that if the third character impulse had been a spacing pulse, the armature of relay RR would have been connected to positive battery and the current flow through the windings HW_r and OW_p would have been reversed. This would cause the holding winding HW_r to hold the armature of relay RR against its spacing contact so long as the brush of the distributor is upon segment 3 of the distributor. The current through the operating winding OW_p of relay TR would now be flowing in such a direction as to cause the armature of said relay to rest upon its marking contact, and a negative marking pulse would be sent to the line, both relay RR and relay K_3 being at this time in spacing condition.

Similarly, when the brush arm reaches segment 4, if the fourth received impulse of the Baudot code is a marking impulse, it will be evident from inspection that relay K_4 in the fourth level of the switches is also in marking condition and, therefore, the transmitting relay TR will shift its armature to its marking contact, if it is not al-

ready resting there. The circuit in this instance will be from negative battery, over the armature of relay RR, through the upper operating window OW_n, over conductor 12, front contact of relay K_4, 4th segment of the distributor, and thence over circuit elements previously traced to the holding winding HW_r. Obviously, if the 4th pulse of the Baudot code corresponding to the character to be enciphered happened to be a spacing impulse, the current flow through the winding OW_n would be reversed and the armature of the relay TR would be shifted to its spacing contact, so that a positive pulse would be sent over the outgoing line TL.

Finally, considering the fifth impulse of the received Baudot code, it will be evident from inspection that relay K_5 for the existing setting of the switches is energized and, therefore, in marking condition. Consequently, if the 5th received impulse is a marking impulse, the current will flow through the upper operating winding OW_n in such a direction as to shift the contact of the relay TR to its marking position to send out a negative pulse to the line TL. If the received impulse is a spacing pulse, however, the flow of current will be in the reverse direction, and the winding OW_n will shift the armature of the relay TR to its spacing contact and send out a positive pulse to the line TL.

As soon as the wiper of the distributor TD leaves segment number 5 of the outer ring, winding HW_r will be deenergized and relay RR will respond to the stopping impulse, which is always a marking impulse. The relay RR will, therefore, have its armature on its marking contact and a circuit will be completed from marking battery over said armature, over conductor 10, through the operating winding OW_p of relay TR, over conductor 24 to the stop segment in the outer ring of the distributor, and thence over the brush to the long inner segment 16, from which point it proceeds over conductor 17 and through winding HW_r to ground. So long as the brush is upon the stop segment, the holding winding HW_r will hold the armature of the relay RR upon its marking contact to prevent it from responding to the succeeding starting impulse (if one immediately follows) before the cycle of operations is completed. While the brush passes over the stopping segment, the operating winding OW_p of the relay TR shifts the armature of said relay to its marking contact so that a negative stop impulse will be sent to the line TL. Since the holding winding HW_t receives current in such a direction as to tend to hold the armature of relay TR against its marking contact, the marking impulse sent to the line will continue even after the brush of the distributor leaves the stop segment, and indeed, will be maintained until the succeeding start impulse sets up a new cycle of operation to encipher a new character.

Coming back to the distributor TD, as the wiper leaves the stop segment it will come to rest on the zero segment of the outer ring engaging with the armature of the release magnet RM. Release magnet RM, however, will not be operated until the succeeding start impulse comes in from the circuit RL. The succeeding starting impulse, which is always a space impulse, will shift the armature of the relay RR to its spacing contact and operate the release magnet RM over conductors 19 and 15, as previously described, to start a new cycle of operation.

Let us now return to the condition existing while the brush of the distributor TD was passing over the stop segment, and thereby transmitting the stop impulse to the line TL. During the entire rotation of the distributor up to this point the various selectors A, B, C, D and E were all set at the positions illustrated in the drawings to impose upon the relays K_1 to K_5, inclusive, an enciphering combination for scrambling the received Baudot code in accordance with the setting of the switches. When the brush reaches the stop segment, however, a switch-controlling cam SC momentarily closes its contact and connects ground to conductor 18 and thence over the key K_a, over right-hand back contact of relay A_1, through the winding of the step magnet M_a to positive battery. Step magnet M_a is energized, and as it pulls up its armature, the pawl of the armature (not shown) is advanced to engage a new tooth in the stopping ratchet wheel of the selector A.

At its right-hand contact step magnet M_a opens the short circuit about the right-hand winding of relay A_1 (which is also connected to conductor 13), so that relay A_1 is energized. At its right-hand front contact relay A_1 is locked up over its right-hand winding so long as the contact made by the cam SC remains closed. When the relay A_1 locks up, it opens at its right-hand armature the circuit previously traced through the stepping magnet M_a, which is released to advance to selector A one step so that all of its brushes now rest upon the 7th contact. The other selectors remain as before. As soon as the cam SC releases its contact the circuit over conductor 18 is opened and locked-up relay A_1 is deenergized so that the circuit of the stepping magnet M_a is prepared for a new stepping impulse, which will occur when the cam SC again closes its contact after another rotation of the distributor.

With the selector A advanced to its seventh contact, a new scrambling condition is set up in each bank upon the relays K_1 to K_5, inclusive. If we trace the circuits, it will be evident that in the first level, in accordance with the new setting, relays F_1 and G_1 will be energized, relay H_1 will be deenergized, and relay K_1 will be energized to shift its armature to marking condition. Tracing through the circuits of the other levels, it will be evident that relay K_2 will be deenergized, relay K_3 will be energized, relay K_4 will be energized and relay K_5 will be deenergized. Consequently the new scrambling code will be mark-space-mark-mark-space, whereas the previous scrambling code was space-mark-space-mark-mark. In other words, in this instance each pulse of the group of five is reversed, except the 4th one which is unchanged. This is due to the fact that in the 4th level the wiper of selector A passes from a 6th contact, which was negative to a 7th contact which is also negative, whereas the wipers of the other levels of selector A all happened to pass from a contact of one polarity to a contact of opposite polarity.

It will be noted that the 6th level of each of the selectors has a set of contacts which are connected through individual lamps to positive battery. With all of the selectors in the position shown in the drawings the brush of the 6th bank of selector A is resting upon the 6th contact, and, therefore, the 6th lamp of the group associated with selector A will glow, indicating that the selector is in its 6th position. At the same time the lower brush of selector B is on its 18th contact so that its 18th lamp glows. Also the lower brush of selector C is on its 14th

contact and causes the 14th lamp in its group to glow while the lower brush of selector D is on its 20th contact causing the 20th lamp of that group to glow. Finally, the lower brush of selector E is upon its 14th contact so that the 14th lamp of the last group glows. These lamps indicate the setting of each of the switches. When, as above described, the selector A was advanced from its 6th to its 7th contact, its 6th lamp will be extinguished and the glowing of the 7th lamp will indicate the new setting of said selector. Similarly other changes in the setting of any of the selectors will be indicated by the appropriate lamps.

When selector A has finally been advanced to its 22nd contact, a circuit is completed over its lower brush and the 22nd contact of its 6th level, through the last lamp of the series, and thence over conductor 19, contact of key K_b, back contact of relay B_1, through the winding of step magnet M_b to positive battery. Step magnet M_b upon drawing up its armature advances its pawl to a new tooth of the stepping ratchet, but it does not move the ratchet until the step magnet is deenergized, which occurs as soon as the relay B_1 is locked up upon the opening of the short circuit of its winding by the right-hand contact of step magnet M_b. Selector B is, therefore, advanced from its 18th position to its 19th position. Thus we now have a condition where selector A is upon its 22nd position, selector B in its 19th position, while the other selectors remain in the position shown in the drawings.

As soon as the distributor DT completes another revolution to utilize the new setting, it connects ground to conductor 18 again, thereby advancing the selector A from its 22nd position to its first position. The wiper of selector A in passing from its 22nd contact opens the locking circuit for the relay B_1 of the selector B, which extended over conductor 19 and the 22nd contact of the lower contact of selector A to ground over the lower wiper of selector A. Relay B_1 is restored to normal so that the step magnet M_b is now ready to receive a new impulse after the selector A has again been advanced step-by-step to its 22nd contact. In the meantime twenty-two new scrambling codes have been set up and utilized before the selector B is again advanced.

In a similar manner, when the selector B has been advanced to its 22nd contact, a circuit for step magnet M_c is established and selector C is advanced from its 14th to its 15th position. Each time the selector B is rotated the selector C is advanced to a new position until it finally reaches its 22nd position, when it causes the magnet M_d to step the selector D from its 20th to its 21st position. Finally, after selector D is advanced to its 22nd position, stepping magnet M_e of the selector E advances said selector from its 14th to its 15th position.

To recapitulate, each time the selector A is advanced twenty-two steps, selector B is advanced one step. Each time selector B is advanced twenty-two steps, selector C is advanced one step. Each time selector C is advanced twenty-two steps, selector D is advanced one step, and finally, each time selector D is advanced twenty-two steps, selector E is advanced one step. Thus it is necessary for selector D to rotate over each of its twenty-two steps twenty-two times before the selector E makes one complete rotation step-by-step. This multiplying of the steps necessary for any preceding selector to be advanced before a succeeding selector is advanced one step, results in a possibility of 5,153,632 successive scrambling codes being set up before the succession of key codes begins to repeat itself. Moreover each one of these 5,153,632 combinations is indicated by the glowing of the lamps connected to the lower levels of the five selectors.

As will be observed, keys K_a, K_b, K_c, etc., are provided in the conductors 18 to 22, inclusive. By operating any one of these keys the corresponding selector may be advanced one step manually. If at any time, therefore, the sending operator desires to change arbitrarily to a new setting of the selectors which control the key, he will simply send a message to the receiving operator to inform him what the new setting is to be. Thereupon both operators will manipulate their keys K_a to K_e, inclusive, a proper number of times to advance each of the five selectors A, B, C, D and E to its new setting, after which communication may be resumed as before.

By arbitrarily resetting the enciphering arrangement from time to time before the succession of over five million combinations repeats itself, it is possible to prevent repetition of the complete succession of scrambling characters, and only such repetition of individual characters takes place as will inevitably occur even under random conditions. Obviously, since we only have thirty-two characters in ordinary teletypewriter operation, even when these characters follow each other in a random manner, each character will inevitably be repeated a large number of times in a total of 5,153,632 possibilities, and we may even find the same group of several characters repeated in the same order several times in such a large range of possibilities. But even here these few repetitions will have no meaning to one attempting to "break" the cipher, because each time they will appear in a different environment of preceding and following characters.

It will, of course, be evident that the positive and negative connections to each of the contacts of each of the levels of the several selector switches should be determined on a wholly arbitrary and random basis, so that the resulting enciphering key will have a random base the sequence of which will not be repeated over 5,153,632 operations.

While this invention has been discussed in certain specific arrangements which are deemed desirable, it will be obvious that the general principles herein illustrated may be embodied in other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a plurality of multipoint switches having wipers movable from point to point of said switches, circuits controlled by said switches to produce key pulses, said pulse being of one character if an odd number of said switches rest upon marking points and being of opposite character if an odd number of said switches do not rest upon marking points, and

means acting after a given message character has been combined with key pulses to shift at least one of said switches with respect to the others to produce a new cipher combination for scrambling a succeeding message character.

2. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a plurality of multipoint switches having wipers movable from point to point of said switches, circuits controlled by said switches to produce key pulses, said pulse being of one character if an odd number of said switches rest upon marking points and being of opposite character if an odd number of said switches do not rest upon marking points, means acting after a given message character has been combined with key pulses to shift at least one of said switches with respect to the others to produce a new cipher combination for combining with a succeeding message character, and means to visually indicate the point at which each switch is set.

3. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a plurality of multipoint switches having wipers movable from point to point of said switches, circuits controlled by said switches to produce key pulses, said pulse being of one character if an odd number of said switches rest upon marking points and being of opposite character if an odd number of said switches do not rest upon marking points, a distributor for successively transmitting said key pulses to combine them with corresponding character pulses, and means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the setting of said switches with respect to each other to produce a new cipher combination for combining with a succeeding message character.

4. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a plurality of multipoint switches having wipers movable from point to point of said switches, circuits controlled by said switches to produce key pulses, said pulse being of one character if an odd number of said switches rest upon marking points and being of opposite character if an odd number of said switches do not rest upon marking points, a distributor for successively transmitting said key pulses to combine them with corresponding character pulses, means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the setting of said switches with respect to each other to produce a new cipher combination for combining with a succeeding message character, and means independent of said resetting pulse and controllable at will to reset any or all of said switches to produce a desired relationship between them.

5. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a plurality of multipoint switches having wipers movable from point to point of said switches, circuits controlled by said switches to produce key pulses, said pulse being of one character if an odd number of said switches rest upon marking points and being of opposite character if an odd number of said switches do not rest upon marking points, a distributor for successively transmitting said key pulses to combine them with corresponding character pulses, means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the setting of said switches with respect to each other to produce a new cipher combination for combining with a succeeding message character, means independent of said resetting pulse and controllable at will to reset any or all of said switches to produce a desired relationship between them, and means to visually indicate the point at which each set is set.

6. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of multipoint switches having wipers movable from point to point of said switches, each of said switches having its points activated to produce a marking or a spacing condition, circuits controlled by said switches to produce key pulses, said pulse being of one character if an odd number of said switches rest upon marking points and being of opposite character if an odd number of said switches do not rest upon marking points, and means acting after a given message character has been combined with key pulses to shift at least one of said switches with respect to the others to produce a new cipher combination for scrambling a succeeding message character.

7. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of multipoint switches having wipers movable from point to point of said switches, each of said switches having its points activated to produce

a marking or a spacing condition, circuits controlled by said switches to produce key pulses, said pulse being of one character if an odd number of said switches rest upon marking points and being of opposite character if an odd number of said switches do not rest upon marking points, means acting after a given message character has been combined with key pulses to shift at least one of said switches with respect to the others to produce a new cipher combination for combining with a succeeding message character, and means to visually indicate the point at which each switch is set.

8. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of multipoint switches having wipers movable from point to point of said switches, each of said switches having its points activated to produce a marking or a spacing condition, circuits controlled by said switches to produce key pulses, said pulse being of one character if an odd number of said switches rest upon marking points and being of opposite character if an odd number of said switches do not rest upon marking points, a distributor for successively transmitting said key pulses to combine them with corresponding character pulses, and means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the setting of said switches with respect to each other to produce a new cipher combination for combining with a succeeding message character.

9. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of multipoint switches having wipers movable from point to point of said switches, each of said switches having its points activated to produce a marking or a spacing condition, circuits controlled by said switches to produce key pulses, said pulse being of one character if an odd number of said switches rest upon marking points and being of opposite character if an odd number of said switches do not rest upon marking points, a distributor for successively transmitting said key pulses to combine them with corresponding character pulses, means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the setting of said switches with respect to each other to produce a new cipher combination for combining with a succeeding message character, and means independent of said resetting pulse and controllable at will to reset any or all of said switches to produce a desired relationship between them.

10. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of multipoint switches having wipers movable from point to point of said switches, each of said switches having its points activated to produce a marking or a spacing condition, circuits controlled by said switches to produce key pulses, said pulse being of one character if an odd number of said switches rest upon marking points and being of opposite character if an odd number of said switches do not rest upon marking points, a distributor for successively transmitting said key pulses to combine them with corresponding character pulses, means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the setting of said switches with respect to each other to produce a new cipher combination for combining with a succeeding message character, means independent of said resetting pulse and controllable at will to reset any or all of said switches to produce a desired relationship between them, and means to visually indicate the point at which each switch is set.

11. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of multi-point switches having wipers movable from point to point of said switches, a set of circuit connections related to each of a plurality of points of one of said switches extending to each of a plurality of points of a second of said switches, a set of circuit connections related to each of said plurality of points of said second switch being extended to each of a plurality of points of a third switch when provided, and sets of circuit connections in a similar manner being extended to succeeding switches when provided, character determining elements associated with the last switch of said series, said character determining elements being activated in accordance with the circuits thus extended from switch to switch in the series, means to combine the key pulses formed by said character determining elements with the pulses corresponding to message characters, and means acting after a given message character has been thus treated to shift at least one of said switches with respect to the others to produce a new cipher combination for combining with a succeeding message character.

12. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by mixing the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of multipoint switches having wipers movable from point to point of said switches, a set of circuit connections related to each of a plurality of points of one of said switches extending to each of a plurality of

points of a second of said switches, a set of circuit connections related to each of said plurality of points of said second switch being extended to each of a plurality of points of a third switch when provided, and sets of circuit connections in a similar manner being extended to succeeding switches when provided, character determining elements associated with the last switch of said series, said character determining elements being activated in accordance with the circuits thus extended from switch to switch in the series, means to combine the key pulses formed by said character determining elements with the pulses corresponding to message characters, means acting after a given message character has been so treated to shift at least one of said switches with respect to the others to produce a new cipher combination for combining with a succeeding message character, and means to visually indicate the point at which each switch is set.

13. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of multipoint switches having wipers movable from point to point of said switches, a set of circuit connections related to each of a plurality of points of one of said switches extending to each of a plurality of points of a second of said switches, a set of circuit connections related to each of said plurality of points of said second switch being extended to each of a plurality of points of a third switch when provided, and sets of circuit connections in a similar manner being extended to succeeding switches when provided, character determining elements associated with the last switch of said series, said character determining elements being activated in accordance with the circuits thus extended from switch to switch in the series, means to combine the key pulses formed by said character determining elements with the pulses corresponding to message characters, a distributor for successively transmitting said key pulses to combine them with corresponding message character pulses and means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the setting of said switches with respect to each other to produce a new cipher combination for combining with a succeeding message character.

14. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of multipoint switches having wipers movable from point to point of said switches, a set of circuit connections related to each of a plurality of points of one of said switches extending to each of a plurality of points of a second of said switches, a set of circuit connections related to each of said plurality of points of said second switch being extended to each of a plurality of points of a third switch when provided, and sets of circuit connections in a similar manner being extended to succeeding switches when provided, character determining elements associated with the last switch of said series, said character determining elements being activated in accordance with the circuits thus extended from switch to switch in the series, means to scramble the key pulses formed by said character determining elements with the pulses corresponding to message characters, a distributor for successively transmitting said key pulses to combine them with corresponding message character pulses, means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the setting of said switches with respect to each other to produce a new cipher combination for combining with a succeeding message character, and means independent of said resetting pulse and controllable at will to reset any or all of said switches to produce a desired relationship between them.

15. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of multipoint switches having wipers movable from point to point of said switches, a set of circuit connections related to each of a plurality of points of one of said switches extending to each of a plurality of points of a second of said switches, a set of circuit connections related to each of said plurality of points of said second switch being extended to each of a plurality of points of a third switch when provided, and sets of circuit connections in a similar manner being extended to succeeding switches when provided, character determining elements associated with the last switch of said series, said character determining elements being activated in accordance with the circuits thus extended from switch to switch in the series, means to combine the key pulses formed by said character determining elements with the pulses corresponding to message characters, a distributor for successively transmitting said key pulses to combine them with corresponding message character pulses, means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the setting of said switches with respect to each other to produce a new cipher combination for combining with a succeeding message character, means independent of said resetting pulse and controllable at will to reset any or all of said switches to produce a desired relationship between them, and means to visually indicate the point at which each switch is set.

16. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to other, means to produce said cipher code combi- each other, means to produce said cipher code combinations including a series of switching stages, each of said stages having a plurality of terminals,

a set of character determining elements one corresponding to each unit of the Baudot code, said character determining element being associated with separate terminals of a final switching stage of the series, a set of interstage conductors related to terminals of the next preceding stage, said conductors leading to terminals of said final switching stage, and sets of interstage conductors related to terminals of still earlier stages when provided, each such set leading to terminals of the next succeeding stage, the number of conductors in each interstage set being evenly divisible by the number of said character determining elements, said character determining elements being activated in accordance with circuits extended from stage to stage in the series, means to combine the key pulses formed by said character determining elements with the pulses corresponding to message characters, and means acting after a given message character has been combined with key pulses to shift the connections of at least one of said sets of interstage conductors with respect to the other sets to produce a new cipher combination for combining with a succeeding message character.

17. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of switching stages, each of said stages having a plurality of terminals, a set of character determining elements one corresponding to each unit of the Baudot code, said character determining element being associated with separate terminals of a final switching stage of the series, a set of interstage conductors related to terminals of the next preceding stage, said conductors leading to terminals of said final switching stage, and sets of interstage conductors related to terminals of still earlier stages when provided, each such set leading to terminals of the next succeeding stage, the number of conductors in each interstage set being evenly divisible by the number of said character determining elements, said character determining elements being activated in accordance with circuits extended from stage to stage in the series, means to combine the key pulses formed by said character determining elements with the pulses corresponding to message characters, means acting after a given message character has been combined with key pulses to shift the connections of at least one of said sets of interstage conductors with respect to the other sets to produce a new cipher combination for combining with a succeeding message character, and means to visually indicate the point to which each switching stage is so shifted.

18. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of switching stages, each of said stages having a plurality of terminals, a set of character determining elements one corresponding to each unit of the Baudot code, said character determining element being associated with separate terminals of a final switching stage of the series, a set of interstage conductors related to terminals of the next preceding stage, said conductors leading to terminals of said final switching stage, and sets of interstage conductors related to terminals of still earlier stages when provided, each such set leading to terminals of the next succeeding stage, the number of conductors in each interstage set being evenly divisible by the number of said character determining elements, said character determining elements being activated in accordance with circuits extended from stage to stage in the series, means to combine the key pulses formed by said character determining elements with the pulses corresponding to message characters, a distributor for successively transmitting said key pulses to combine them with corresponding message character pulses, means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the connections of at least one of said sets of interstage conductors with respect to the other sets to produce a new cipher combination for combining with a succeeding message character.

19. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combinations representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of switching stages, each of said stages having a plurality of terminals, a set of character determining elements one corresponding to each unit of the Baudot code, said character determining element being associated with separate terminals of a final switching stage of the series, a set of interstage conductors related to terminals of the next preceding stage, said conductors leading to terminals of said final switching stage, and sets of interstage conductors related to terminals of still earlier stages when provided, each such set leading to terminals of the next succeeding stage, the number of conductors in each interstage set being evenly divisible by the number of said character determining elements, said character determining elements being activated in accordance with circuits extended from stage to stage in the series, means to combine the key pulses formed by said character determining elements with the pulses corresponding to message characters, a distributor for successively transmitting said key pulses to combine them with corresponding message character pulses, means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the connections of at least one of said sets of interstage conductors with respect to the other sets to produce a new cipher combination for combining with a succeeding message character, and means independent of said resetting pulse and controllable at will to reset any or all of the connections of said sets of interstage conductors to produce a desired relationship between them.

20. A system for transmitting messages composed of characters in the form of Baudot code combinations, means to encipher or decipher said messages by combining the message code combinations with successive cipher code combina-

tions representing characters which are unrelated to said message characters either as to order, grouping, frequency of occurrence, or relationship to each other, means to produce said cipher code combinations including a series of switching stages, each of said stages having a plurality of terminals, a set of character determining elements one corresponding to each unit of the Baudot code, said character determining element being associated with separate terminals of a final switching stage of the series, a set of interstage conductors related to terminals of the next preceding stage, said conductors leading to terminals of said final switching stage, and sets of interstage conductors related to terminals of still earlier stages when provided, each such set leading to terminals of the next succeeding stage, the number of conductors in each interstage set being evenly divisible by the number of said character determining elements, said character determining elements being activated in accordance with circuits extended from stage to stage in the series, means to combine the key pulses formed by said character determining elements with the pulses corresponding to message characters, a distributor for successively transmitting said key pulses to combine them with corresponding message character pulses, means synchronized with said distributor to transmit a resetting pulse after said key pulses have been transmitted to change the connections of at least one of said sets of interstage conductors with respect to the other sets to produce a new cipher combination for combining with a succeeding message character, means independent of said resetting pulse and controllable at will to reset any or all of the connections of said sets of interstage conductors to produce a desired relationship between them, and means to visually indicate the reset condition of said connections.

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