Feb. 17, 1953 K. EHRAT 2,629,012

DEVICE FOR PRODUCING CURRENT IMPULSE COMBINATIONS

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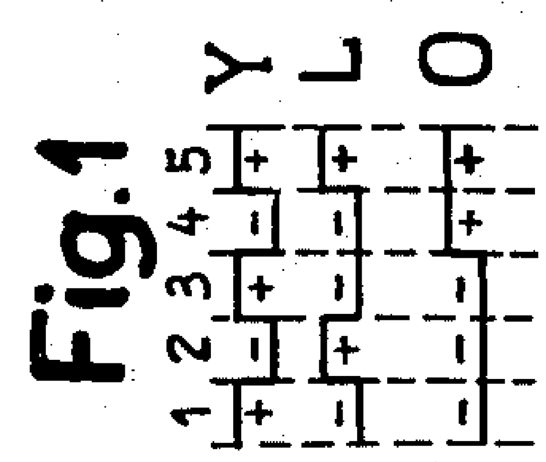


Fig.1

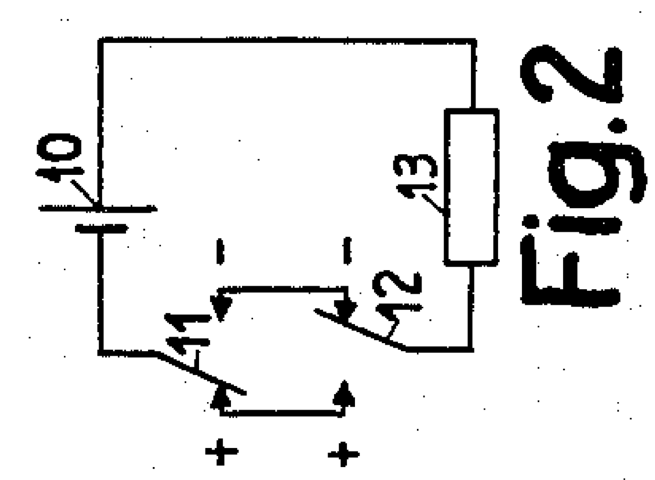
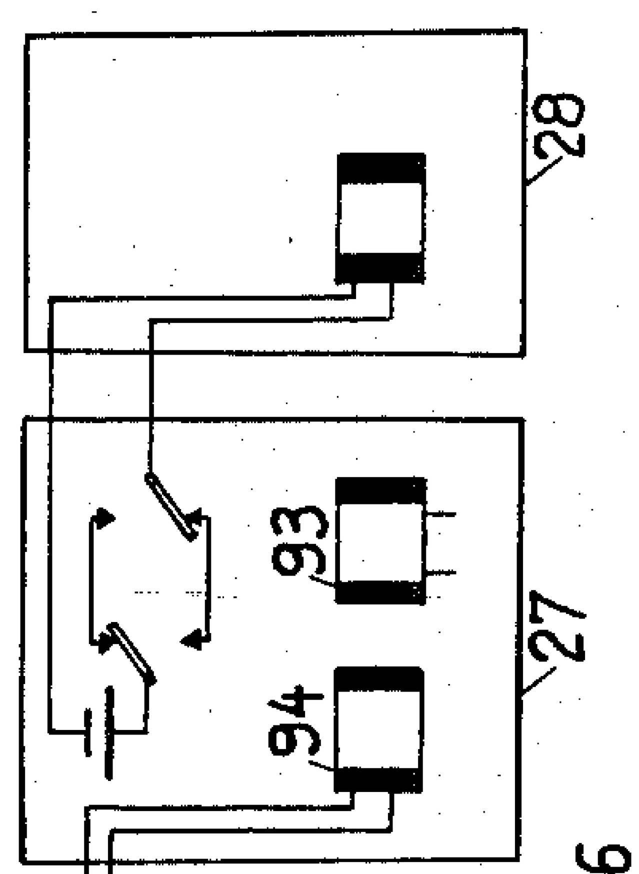


Fig.2



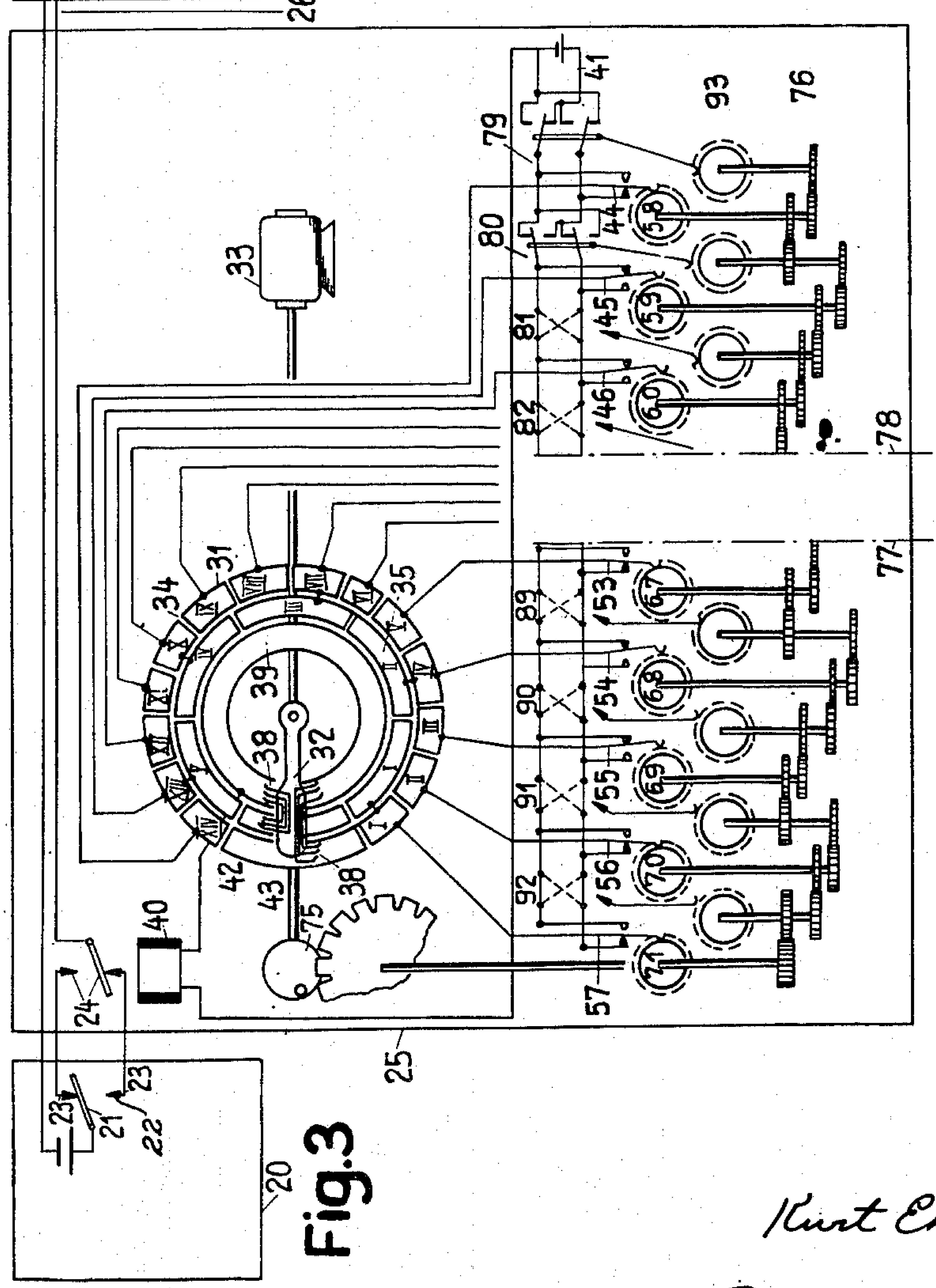


Fig.3

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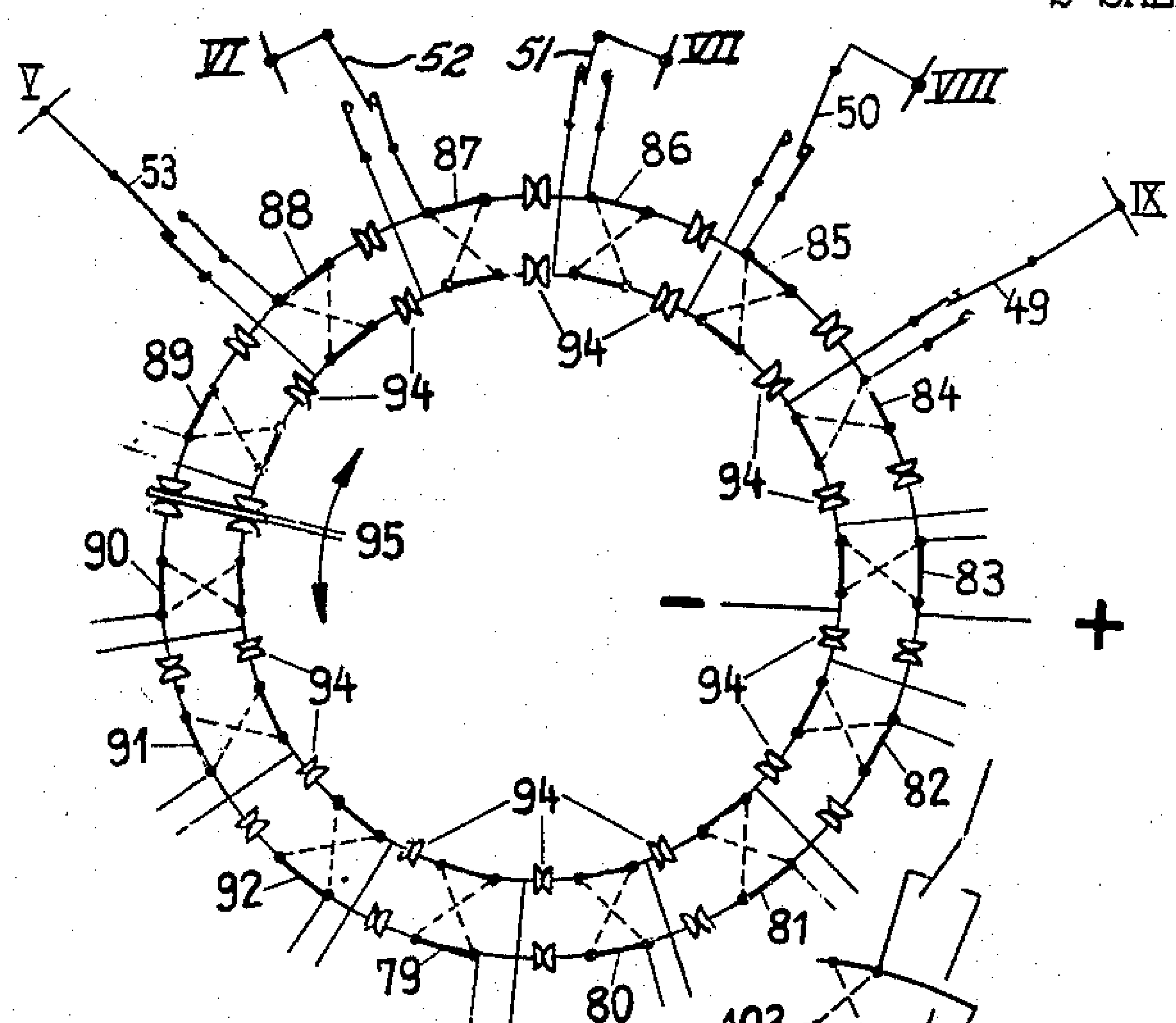
Fig. 4



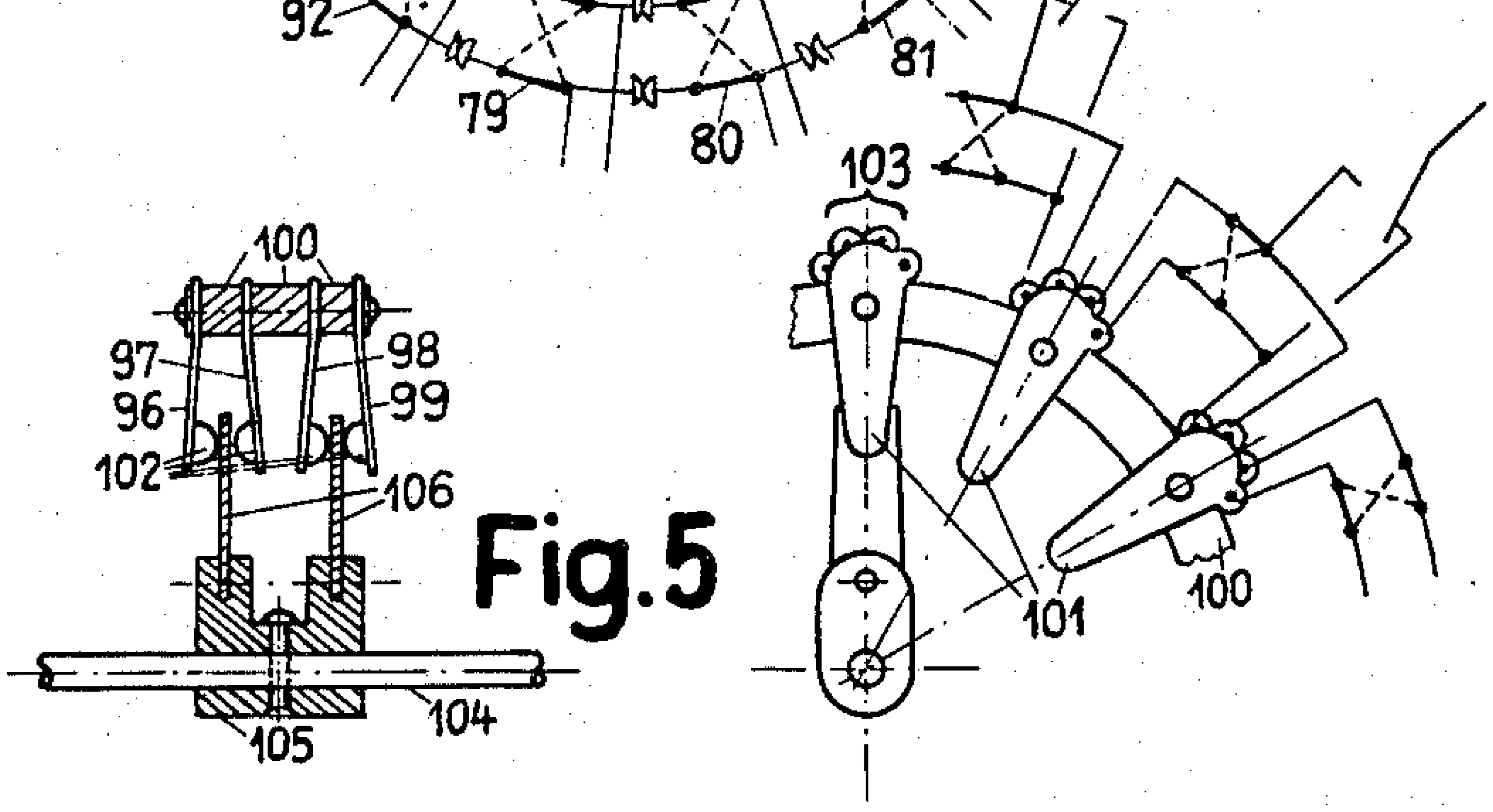
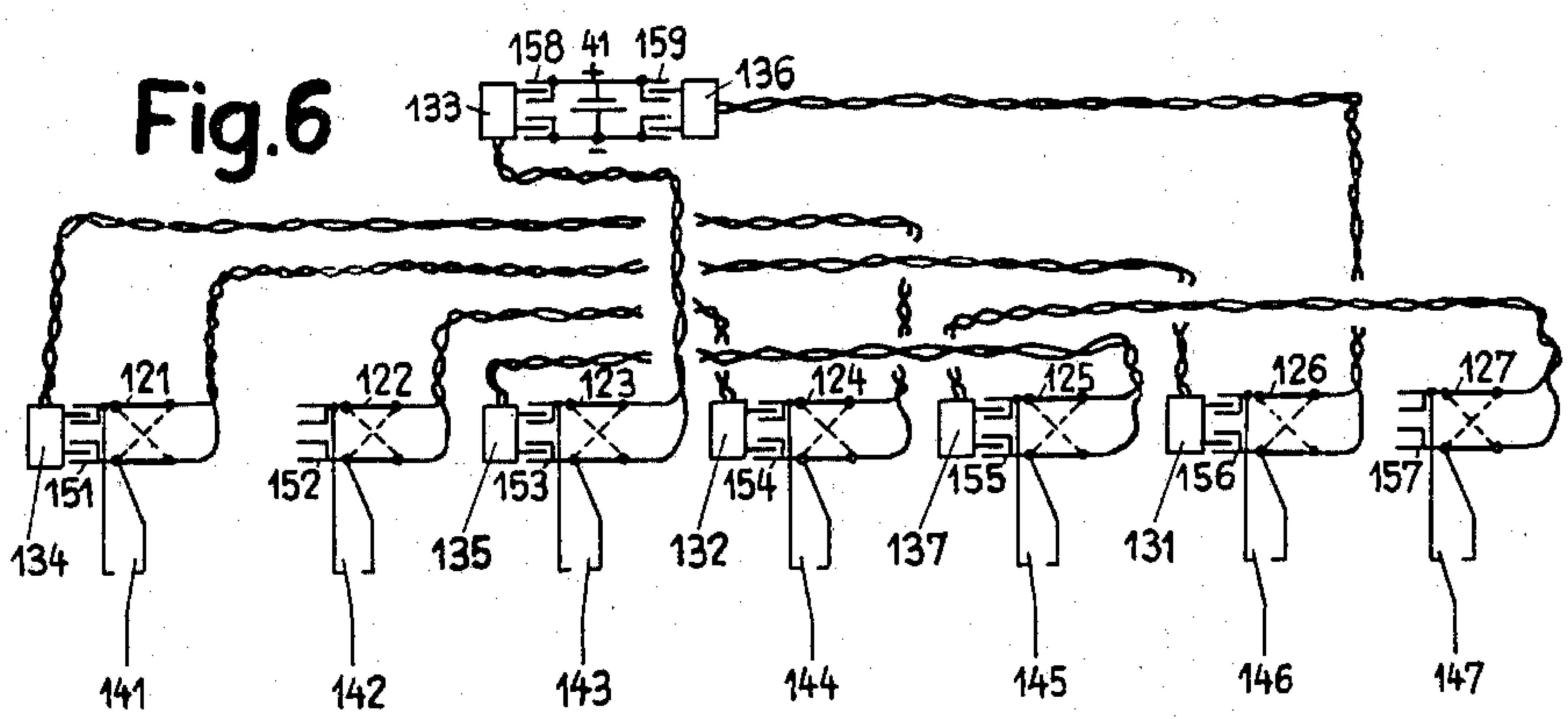


Fig.5

Fig.6



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DEVICE FOR PRODUCING CURRENT IMPULSE COMBINATIONS

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In Switzerland October 5, 1949

14 Claims. (Cl. 178—22)

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The present invention relates to a device for producing current impulse combinations, more particularly for producing enciphering current impulse combinations for use in enciphering systems for telegraphy or teletypewriters.

It is well known that intelligence to be communicated by telegraphy may be kept secret, i. e. made unintelligible to unauthorized persons, by the employment of enciphering devices which at the emplacement of transmitter modify the current impulses corresponding to and transmitting the characters composing said intelligence and which at the emplacement of the receiver reproduce by a reverse process the original current impulses.

Such devices are of particular importance for teletypewriters which employ the standard five-step permutation, or Baudot code. In such a code each letter of the alphabet is characterized by a particular combination of five current impulses, which will hereinafter be referred to as letter impulse combination. Each of the five current steps of such a combination may alternatively be a "marking" or a "spacing" step with a corresponding polarity or "sign" of (+) or (—). This "sign" of each current step may correspond e. g. in a single current system to a current impulse or a no-current impulse respectively, or in a double current transmission system to a positive or negative flow of the transmitting current. In the following description the term "sign of a current step" will be employed in this meaning.

Enciphering devices of the kind to be described are of equal importance for use with other teletypewriter systems, e. g. "monogram printers," which form the different letters of the alphabet at the receiving end by printing in registration a variable number of individual characteristic sign elements, which are selected according to the particular letter to be reproduced from a limited number of such sign elements, e. g. fourteen. For a system employing fourteen characteristic sign elements, as that has been described in U. S. Patent 2,139,452 (Kreuzer) each letter is transmitted by a current impulse combination comprising fourteen current steps, where the sign of each of the fourteen current steps is (+) or (—), i. e. a "marking" or a "spacing" step, according to the characteristic sign elements which compose that particular letter.

In order to encipher current impulse combinations produced by such ordinary teletypewriters or by such monogram printers the enciphering device produces a sequence of continuously varying current impulse combination referred to

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hereinafter as enciphering impulse combinations, the number, length and sequence of which is equal to the employed impulse combination code. Letter impulse combination and enciphering impulse combinations are now combined to form enciphered current impulse combinations. The sign of said enciphered impulse combinations is obtained by a process which may be considered as a multiplication of the signs of the corresponding current steps of letter and enciphering impulse combinations. Though this method of "multiplication of signs" is well known, it will be explained in short with the aid of Fig. 1, to make more clearly understandable the following description of the invention. The uppermost line of Fig. 1 shows a current impulse combination in the well known 5-step code, e. g. for a letter "Y," the current steps of which are designated as 1 to 5. The corresponding enciphering impulse combination shown in the line below may correspond to the letter "L." Marking elements are designated by the sign (+) and spacing elements as (—). The formation of the resulting enciphered current impulse combination is effected according to the following rule:

$- \cdot - = +$ (minus multiplied by minus equal to plus)

$+ \cdot + = +$

$+ \cdot - = -$

$- \cdot + = -$

The lowest line of Fig. 1 represents the result of such a multiplication of signs of the both upper lines. The impulse combination obtained in this way corresponds to the letter "O."

Fig. 2 represents by way of example an electrical circuit which is able to effect such a "multiplication of signs." In the drawing **10** represents a current source, **11** and **12** two make-and-break contacts. The movable member of such contact may assume alternatively two positions making contact with either of two exterior contact members and will be referred to hereinafter as alternating contact. The alternating contact **11**, e. g. the contacts of the transmitter relay of a teletypewriter may be actuated in correspondence with the current impulse combination of the letter "Y" shown in Fig. 1. The contact **12** which represents the enciphering contact is actuated according to the enciphering impulse combination "L." For both contacts the position of making contact with the left exterior contact member is designated as (+) and the position of making contact with the right member as (—). The position of the contacts as actually shown corresponds to the first or third impulse of the impulse combinations shown in Fig. 1. According to the position of both contacts no current (—) will flow through the resistance 13. A simple consideration will show that such a circuit is in fact able to effect a multiplication of signs according to the above rule. With identical position of both contacts, i. e. 11 and 12 to the left (+·+), or 11 and 12 to the right (—·—), a current flows through resistance 13 (+), with contacts in opposition, i. e. 11 to the right and 12 to the left (+·—), or 11 to the left and 12 to the right (—·+), the circuit is open and no current flows through the resistance 13 (—).

It is now the task of an enciphering device to produce an enciphering impulse combination for any letter of the message to be transmitted and to actuate contact 12 accordingly.

The sequence of enciphering impulse combinations produced by the enciphering device according to a predetermined rule and actuating the enciphering contact may be considered as the "enciphering key" of such a device. The deciphering or "breaking the cipher" of such an enciphered message by unauthorized persons will be the more difficult the less lawful the key, i. e. the more the different enciphering impulse combinations of the key follow at random. In the ideal case the sequence of varying enciphering combinations will be only subject to the laws of probability calculus. The mechanical production of consecutive enciphering impulse combinations will, however, unavoidably show a certain lawful relationship in the composition of such combinations. The security against unauthorized deciphering of messages will now be the higher, the less such regularities are apparent and the more such a key approaches an ideal random distribution. Furthermore a knowledge of the enemy of the enciphering device must always be assumed. It must therefore be possible to change the key, i. e. to vary the sequence of enciphering impulse combinations in an identical way at the transmitter and the receiver enciphering device. In order to simplify its operation a device will permit a variability of the key of highest possible degree with a smallest possible amount of mechanical alteration of the device. Additionally the effected variation of the key must not be apparent and must not show any regularities. Enciphering devices that have become known till now effect the production of the sequence of enciphering impulse combinations by the employment of means well known in the art of teletypewriting. Thus key tapes are employed which contain a multitude of enciphering impulse combination impressed at random distribution, or cam wheels which act upon contacts which in turn actuate the enciphering contact of such an enciphering device. Whereas the employment of enciphering key tapes presents the inconveniency that the tape is not very resistant to the wear and tear of continuous operation, the employment of cam wheels limits the attainable degree of secrecy. If the size of such wheels or the number of wheels employed is not to exceed certain reasonable limits set by considerations of construction and practical application the ideal of a random distribution of consecutive enciphering impulse combinations is far from attainable.

It is therefore an object of the present invention to provide an apparatus for producing enciphering current impulses which will permit enciphering of telegraphic messages with a high degree of secrecy.

It is another object of the invention to achieve an increased degree of secrecy of enciphered messages, by providing means for the variation of the enciphering key, effecting a maximum variation of the key with a minimum of alteration of the enciphering device.

It is furthermore an object of the invention to provide an electrical circuit permitting the production of a sequence of enciphering impulse combinations with a high degree of variability.

It is furthermore an object of the invention to provide an electrical circuit where a minimum of elements may influence a maximum number of other elements.

One feature of the present invention resides in the employment of an electrical circuit, which possesses a certain number of electrical outputs, an equal number of alternating contacts, each related to one of said outputs, an equal or larger number of commutator switches, the outputs of each which are connected to one of said contacts, and which switches are connected in series to form at least one cascade, and a current source, which supplies current to a deliberately chosen point of each of said cascades formed by said commutator switches.

A device according to this invention can advantageously be employed alternatively in cooperation with teletypewriters employing different current steps codes, e. g. five step code and fourteen step code where the available number of commutator contacts may be utilised in any case if not totally but to an extent superior to that of other known constructions.

The invention is, however, by no means restricted to the production of enciphering impulse combinations or to cooperation with teletypewriters, as the device may also advantageously be employed in any case where the production of a sequence of current impulse combinations with ideal or approximately ideal random distribution is of importance. In the following description of a device according to the invention, however, reference will be made to its application for enciphering purposes, as this represents one of the most important fields of application.

The above noted objects and other features and objects will be brought out in the course of the following detailed description with reference to the accompanying drawings, wherein:

Figs. 1 and 2 serve to explain the principles of forming enciphered current step combinations employing the method of "multiplication of signs."

Fig. 3 by way of example shows an embodiment of the invention in schematic representation.

Figs. 4 and 6 show details of the circuits employed, and

Fig. 5 structural details of another embodiment of the invention.

Fig. 3 schematically shows an embodiment of the invention where 20 represents a teletypewriter, the transmitting contacts 21 of which establish contact with either the point 22 or 23 according to the desired sign of the current steps of the letter impulse combinations to be transmitted. The exterior contact members 22 and 23 are connected to exterior members of the enciphering contact 24 of the enciphering device 25, thus effecting a "multiplication of signs" according to the principle explained with reference to Fig. 2. By way of such a "multiplication of signs" the letter impulse combinations produced by the teletypewriter 20 are transformed into the enciphered impulse combinations by the enciphering contact 24. The enciphered impulse combinations are now transmitted over line 26 to the emplacement of the receiver where another enciphering device 27 and a teletypewriter 28 are located. After deciphering the received enciphered impulse combinations by the enciphering device 27 the receiving teletypewriter 28 will reproduce the original message in clear language.

In the case shown the enciphering device 25 will serve for enciphering and the enciphering device 27 for deciphering. If a message is to be transmitted in the reverse direction both devices operate in the opposite way. This switching over of enciphering devices is possible without further difficulty as the method of operation is the same for enciphering and for deciphering. In the following description therefore only the device 25 employed for enciphering will be described.

The enciphering device 25 comprises an enciphering relay 40 with the enciphering contact 24, a distributor 31, fourteen commutator switches 79–92 arranged in cascade, fourteen alternating contacts 44–57, two sets of each fourteen cam wheels 58–71 and 93 for actuating the commutator switches and alternating contacts and the drive mechanism for distributor and cam wheels.

The contact arm 32 of the enciphering distributor 31 is rotated by a motor 33 synchronously with the transmitting distributor inside the teletypewriter 20. The distributor 31 is fitted with two segmented rings 34 and 35, which as shown by way of example in the embodiment are divided into five and fourteen segments, respectively, in order to permit the employment of the device alternatively with teletypewriters using a five-step or a fourteen-step code. The contact arm 36 of the enciphering distributor 31 may now alternatively slip on the fourteen-segment ring 34 by means of a brush 37 or on the five-segment ring 35 by means of brush 38. The brushes then connect either the segments of ring 34 or of ring 35, respectively, to a contact ring 39. The contact ring 39 is connected to one terminal of the winding of the enciphering relay 40, whereas the other terminal is connected to the positive terminal of a current source 41. Additional segments 42 and 43 of the segmented rings 34 and 35 may e. g. serve to keep up synchronism between transmitter and receiver by the employment of additional means well known in the art. As such means do not form part of the present invention they are not shown in the drawing for the sake of clearness. The interval during which the brushes slide over this additional segment may be used to prepare, e. g. by changing the position of alternating contacts and commutator switches, the enciphering impulse combination which is to be formed in the succeeding interval.

The individual segments of the fourteen-segment ring 34 are each connected to the center member of one of a series of fourteen alternating contacts 44–57 which are each actuated by an appertaining cam wheel 58–71. In the embodiment shown the segments I, IV, VII, X and XIII of the fourteen-segment ring 34 are connected at the same time to segments I, II, III, IV, and V of the five-segment ring, respectively. The two exterior members of each alternating contact are connected to a current source 41 through a cascade arrangement of commutator switches 79–92, which is to be explained in detail below.

Such cam wheels 58–71 and 93 or similar devices which serve to actuate alternating contacts and commutator switches are well known in the art and a construction particularly useful in such enciphering device has been described in the co-pending application of Edgar Gretener, Serial No. 186,998, filed September 27, 1950. The sequence of cams and dwells on such a disc, or the sequence of active and non-active members on similar devices, may be set by hand thereby changing the program according to which the conjugate contact of switch is actuated in an arbitrary manner.

The cam wheels 58–71 and 93 are rotated by motor 33 through a step-by-step gear 75. As the pinion of this gear only has one driving pin, the cam wheel 71 actuating contact 57 is rotated by one single step for every full rotation of the contact arm 32, viz. after the formation of a complete current impulse combination. The width of such steps preferably corresponds to the pitch of the cams on the cam wheel. The other cam wheels 70–58 are actuated by the motor 33 through additional intermediate gears 76. In the drawing for the sake of clearness part of the alternating contacts, commutator switches and corresponding cam wheels and gears are not shown as that is indicated by dotted lines 77 and 78 and the gears are shown as toothed wheels. Preferably, however, step-by-step gears are employed, which during the intervals between the current impulse combinations rotate the cam wheels only by full amounts of the pitch of the cams or multiples thereof. By an appropriate choice of the ratios of the different gears and of the number of cams on each wheel it may be achieved that the enciphering device reaches the initial relative position of all contacts and cam wheels only after running through all possible positions of the fourteen cam wheels. This means that the length of the "enciphering key" is made as long as possible.

In order to vary the "key" itself, the position of each individual cam wheel in relation to the others can be varied by hand e. g. by the aid of friction clutches between the cam wheels and the appertaining gear, thus presenting another possibility of varying at will the enciphering key.

If the exterior terminals of the fourteen alternating contacts 44—57 were connected directly to the current source 41 the polarity of each of the fourteen segment of the enciphering distributor 31 required in a fourteen-step code system, would depend only upon the position of one single alternating contact, i. e. one single cam wheel, thus permitting only a very poor approximation to the ideal state of random distribution of enciphering code combinations.

To compensate for this inconvenience, the exterior terminals of the fourteen alternating contacts are not directly connected to the current source 40. Fourteen commutator switches 79–92 are arranged in series to form an electrical cascade. Each commutator switch consists of two alternating contacts as may be seen from the wiring diagram of switches 79 and 80. The centre contact members are mechanically connected so as to assume corresponding position. Consequently a commutator switch corresponds to a two-poled double-throw switch. The centre contact members are electrically connected to the two output terminals of the commutator switch whereas the four exterior contact members are connected to the two input terminals of the switch in such a way, that in the one position of the centre contact members, e. g. that shown by switch 79 of the drawing, the upper output terminal is connected to the lower input terminal and vice versa, whereas in the other position, e. g. that shown by switch 80, the upper output terminal is connected to the upper input terminal and vice versa. Only the commutator switches 79 and 80 have been shown in their electric details whereas for the other commutators a symbolic representation has been chosen which is to indicate that the output terminals are connected to the input terminals either directly or crosswise. The switches are now connected in series by connecting the output terminal of the foregoing switch, e. g. 79 to the input of the following switch, e. g. 80. In such a way a "cascade" of commutator switches is formed, which means that the effect of the succeeding switches is superposed.

The exterior contact members of each of the fourteen alternating contacts are connected parallel to the output terminals of each commutator switch. Consequently each alternating contact is connected to the current source 41 through a varying number of commutator switches. Thus e. g. contact 44 is connected to the source 41 through commutator 79, contact 45 through commutators 79 and 80, contact 46 through commutators 79, 80 and 81, and so on.

The commutator switches 79–92 are actuated by fourteen additional cam wheels which are likewise rotated in steps by means of gears 76 by motor 33. In order to obtain a most close approach to an ideal random distribution of enciphering code combinations the above mentioned requirement must be equally met with by the construction of gears and cam wheels.

The enciphering device now works as follows: A letter may be transmitted by the teletypewriter 20, which may e. g. work according to the start-stop principle. The starting impulse of the teletypewriter starts, by means well known in the art and therefore not shown in the drawing, motor 33 of the enciphering device. The contact arm 32 is set to rotate and successively connects the enciphering relay 40 to the segments of the enciphering distributor in the rhythm of the letter impulse combinations formed by the teletypewriter. As the other end of the relay winding is connected to the positive terminal of the source 41 the armature will attract if the individual segment shows a positive polarity (+) or will fall off, if the segment shows negative polarity (−).

In the shown position of commutator switch 79 the right exterior contact member of the alternating contact 44 is connected to the negative, the left terminal to the positive terminal of the source 41. As the centre member of contact 44 engages the left exterior contact member, the segment I of the enciphering distributor is electrically connected to the positive terminal of the source and assumes a polarity (+). For the segment II the following circuit may be traced: Center member 45, right exterior member 45—upper output and input commutator 80—upper output commutator 79—lower input commutator 79—(−) negative terminal current source 41, viz likewise a polarity (+). The polarity of segment III depends upon the position of alternating contact 46 and upon the commutator switches 81, 80, 79, segment IV of alternating contact 47 and commutator switches 82, 81, 80, 79 and so forth.

If the contact arm has successively moved over all fourteen segments, it is again put to rest after reaching the segment 42. The actuation of the enciphering contact 24 according to the polarity of segments produces a "multiplication of signs" of the signs of the letter impulse combination formed by the teletypewriter and of the enciphering impulse combinations of the enciphering device. After the brush has again arrived on the segment 42 the cam wheel 71 appertaining to alternating contact 57 is rotated by the step-by-step gear 75 by at least one step corresponding to the pitch of cams on that wheel. Depending upon the relative position in that moment of the other gears 76 several others of the cam wheels may also be transported by full steps of cam pitch. The enciphering device is then ready and prepared for the forming of the following enciphering impulse combination. If the following letter is transmitted by the teletypewriter the entire cycle of operation is repeated. Due to the rotation of one or more cam wheels which may have taken place in the interval between the forming of both enciphering combinations, the relative position of cam wheels and correspondingly of alternating contacts and switches has changed and the polarity of the fourteen segments is completely different. The letter impulse combination is multiplied with an entirely different enciphering impulse combination. If the enciphering device is employed in cooperation with a five-step code the position of the enciphering contact depends upon the polarity of the five segments of ring 35 which are scanned by brush 38 in synchronism with the five current steps formed by the teletypewriter.

The enciphering device at the emplacement of the receiver is working in exactly the same way. The enciphering relay 93 is connected in such a way that the "multiplication of signs" of the received enciphered impulse combinations over line 26 by a relay 94 with the enciphering current impulse combinations formed by the device 27, produces the original signal current impulse combinations transmitted by the teletypewriter 20. Consequently the message received by teletypewriter 28 is composed of clear language letter combinations.

The arrangement of commutator switches in cascade as shown in the embodiment of Fig. 2 offers the following advantages: fourteen commutator switches are connected to form an electric cascade to which current is supplied by source 41. The alternating contacts are each electrically connected to the output of one of the commutator switches within the cascade.

The polarity of every individual segment obtained as a result of the position of the appertaining contacts may be spoken of as "final criterion" which determines the sign of the appertaining current step, whereas the varying position of the individual alternating contacts and commutator switches may be spoken of as "partial criterion." The total number of "final criteria" in an enciphering device employing "multiplication of signs" must be equal to the total number of current steps necessary for the transmission of every character, whereas the number of "partial criteria" responsible for every individual "final criterion" should be made as large as possible with the object of increasing the difficulties for unauthorized deciphering.

The embodiment shown possesses twice fourteen "partial criteria," viz. fourteen commutator switches and fourteen alternating contacts, or in a more general case $n+v$ partial criteria by the employment of n alternating contacts and v commutator switches. Every contact or switch is actuated separately by a conjugate cam wheel. Every "final criterion," viz. the polarity of the fourteen segments depends upon a considerable number of partial criteria due to the effect of the electrical cascade. In the embodiment shown it depends in the average upon 7,5+1=8,5 partial criteria. If now the position of one single cam wheel actuating a commutator switch is altered leaving unchanged the position of all other cam wheels, the distribution of enciphering combinations is varied to a very great extent, as this one commutator switch determines the polarity of in the average a very great number of segments. If in contrast to this for every segment only one commutator switch would have been employed in series to one alternating contact and directly connecting said contact to the terminals of the current source only two partial criteria should determine every final criterion.

As has already been mentioned a further advantage resides in the possibility of using the device alternatively for teletypewriters of different combination code systems with a different number of current steps, where still in any case a very large number of partial criteria is effective for each of the final criteria which correspond in number to the number of separate current steps of the employed code system. If e. g. the enciphering device is to operate with a fourteen-step code as well as with a five-step code, the enciphering device must be capable of producing fourteen final criteria. The employed number of twenty-eight partial criteria may to a very great extent be all utilized for the five-step code. Though in this case only five of the fourteen final criteria are exploited, the five final criteria depend upon the position of five alternating contacts and of fourteen commutator switches, i. e. in the average on 8+1=9 partial criteria, whereas for a simple circuit employing one alternating contact and one commutator switch in series only two partial criteria would be effective for every final criterion.

Fig. 4 shows as another embodiment of invention a ring shaped arrangement of the commutator switches forming a cascade. For simplicity of illustration identical numerals have been employed for items identical in Figs. 2 and 3. The commutator switches forming the ring are connected through separating contacts 94, which permit to cut the ring at any desired point between two switches, e. g. as shown between switches 89 and 90. The point of separation may change its place during operation of the device, e. g. after producing each enciphering current impulse combination. The separation is effected according to the embodiment shown by an insulating plate urged in between the separation contact at the desired point. The final criteria are received as in the embodiment of Fig. 3 through the intermediary of alternating contacts 44–57 at the segments I to XIV of the distributor, as indicated in Fig. 4. The cam wheels actuating the contacts and switches are not shown for the sake of clearness of explanation as the feature of invention resides only in the electrical arrangement of contacts and switches. The current may be supplied to the ring cascade at any point 95 e. g. to the input of switch 83. In the position of the separation plate shown in Fig. 4 two cascades of commutator switches are formed one consisting of switches 82, 81, 80, 79, 92, 91 and 90 and a second one consisting of switches 83, 84, 85, 86, 87, 88 and 89. The polarity of e. g. segment V of the distributor depends upon the positions of switches 83, 84, 85, 86, 87, 88 and/contact 53. If the separating plate 94 is rotated in the sense of clock by one step, now separating the ring between switches 87 and 88, the polarity of the same segment V will depend upon switches 89, 90, 91, 92, 79, 80, 81, 82 and, of course as before, of contact 53. It is easily understood that such a minor change, which is easy to be effected at the two enciphering devices of transmitter and receiver, will vary the enciphering key to a very great extent.

Figs. 5a and 6 by ways of example schematically show in side view and section how such separating contacts may be constructed. The embodiment somewhat resembles to the construction of selection switches well known in the art of automatic telephony. Four flat contact springs 96, 97, 98 and 99 composing one separation contact are mounted on insulating rings 100. The interior ends 101 of the flat spring support the real contacts 102, whereas the exterior ends 103 form ears for soldering the connection wires. The connections between such terminals necessary for the formation of ring shaped cascade are schematically indicated in Fig. 5. The shaft 104 supports two insulation plates 106 on a bushing 105 which according to the drawing are urged between the separation contact pairs 96—87 and 89—99.

Fig. 6 schematically shows another embodiment permitting to form two cascades of commutator switches, where the switches may voluntarily be attributed to one or the other of two cascades in any desired sequence. For this purpose the entrance terminals input of the seven commutators 121—127 are connected to a double poled socket 131—137. The output terminals of the commutator switches which are at the same time parallel to the exterior contact springs of the appertaining alternating contacts 141—147 are connected to the double poled plugs 151—157. The current source 41 is fitted with two double poled sockets 158 and 159. By deliberately plugging any one of plugs 131—137 into one of sockets 151—157 or into sockets 158—159 of the source any desired sequence of switches within the two cascades may be obtained. The sockets of the switch forming the end of each cascade stay open.

According to the connections shown two cascades are formed as follows:

1. Cascade:

Sockets 158—plug 133—switch 123
Sockets 153—plug 135—switch 125
Sockets 155—plug 137—switch 127—socket 157 open

2. Cascade:

Sockets 159—plug 136—switch 126
Sockets 156—plug 131—switch 121
Sockets 151—plug 134—switch 124
Sockets 154—plug 132—switch 122—socket 152 open

The first cascade consequently comprises three switches 123—125—127 where switch 123 lies nearest to the current source 127, whereas the second cascade is formed by four switches 126—121—124—122, where the current is supplied to switch 126.

For simplicity of illustration the segment of the enciphering distributor have been omitted in Figs. 5a and 5b.

The possibilities of this embodiment serving only for illustration are, however, not limited to two cascades. It is evident that by employing the principles of the present invention in principle and infinite variety of combination of members providing "partial criteria" be achieved.

I claim:

1. In an electrical circuit including an enciphering distributor with a number n of segments connected to a coding device; the combination of a source of direct current, leads connected to the opposite terminals of said source, a number n of polarity reversing commutator switches in series in said leads, and a number n of polarity altering switches connected to said leads, each polarity altering switch being separated from an adjacent polarity altering switch by a polarity reversing switch, the fixed contacts of each polarity altering switch being connected to the respective leads and the movable contacts being connected to the respective segments of the enciphering distributor.

2. In an electrical circuit including an enciphering distributor with a number n of segments connected to a coding device; the combination of a source of direct current, a number n of polarity reversing commutator switches in series, the input terminals of the first polarity reversing switch of said series being connected to the opposite terminal of said source, and the input terminals of the other polarity reversing switches each being connected to the output terminals of the preceding polarity reversing switch of said series, and a number n of polarity altering switches connected to said polarity reversing switches, each polarity altering switch being separated from an adjacent polarity altering switch by a polarity reversing switch, the fixed contacts of each polarity altering switch being connected to the output terminals of one of said polarity reversing switches and the movable contacts being connected to the respective segments of the enciphering distributor.

3. In an electrical circuit including an enciphering distributor with a number n of segments connected to a coding device; the combination of a source of direct current, a number n of polarity reversing commutator switches in series, the input terminals of the first polarity reversing switch of said series being connected to the opposite terminal of said source, and the input terminals of the other polarity reversing switches each being connected to the output terminals of the preceding polarity reversing switch of said series, and a number n of polarity altering switches connected to said polarity reversing switches, each polarity altering switch being separated from an adjacent polarity altering switch by a polarity reversing switch, the fixed contacts of each polarity altering switch being connected to the output terminals of one of said polarity reversing switches and the movable contacts being connected to the respective segments of the enciphering distributor, and a multitude of means actuating separately and according to a preset program said polarity reversing switches and said polarity altering switches.

4. In an electrical circuit as set forth in claim 3, said actuating means being selectively rotatable with said distributor.

5. In an electrical circuit as set forth in claim 3, said distributor being rotatable through one turn for each group of n current impulses.

6. In an electrical circuit including an enciphering distributor with a number n of segments connected to a coding device; the combination of a source of direct current, a number n of polarity reversing commutator switches connected in series to form at least two groups, the input terminals of the first polarity reversing switch of each of said groups being connected to the opposite terminals of said source and the input terminals of the other polarity reversing switches of each group being connected to the output terminals of the preceding polarity reversing switch of said group, and a number n of polarity altering switches connected to said polarity reversing switches, each polarity altering switch being separated from an adjacent polarity altering switch by a polarity reversing switch, the fixed contacts of each polarity altering switch being connected to the output terminals of one of said polarity reversing switches and the movable contacts being connected to the respective segments of the enciphering distributor.

7. In an electrical circuit, the invention as set forth in claim 6, in combination with electrical coupling means at each side of each polarity reversing commutator switch and manually operable to determine the number of polarity reversing commutator switches in each of said groups.

8. In an electrical circuit, the invention as recited in claim 6, wherein said electrical coupling means are switches for connecting all of said polarity reversing commutator switches in a ring arrangement, and an operator is manually adjustable to open a desired one of said coupling means switches.

9. In an electrical circuit, the invention as recited in claim 6, wherein said coupling means comprise detachable pin and socket connectors, whereby both the number and the relative arrangement of the individual polarity reversing commutator switches in each group may be varied at will.

10. In an electrical circuit including an enciphering distributor with a number n of segments connected to a coding device; the combination of a source of direct current, a number n of polarity reversing commutator switches connected in series to form a closed ring, the input terminals of each of said polarity reversing switches being connected to the output terminals of the preceding polarity reversing switch, electrical connecting means between said input terminals and output terminals and selectively operable to interrupt said closed ring between any two of said polarity reversing switches, the input terminals of one of said polarity reversing switches being connected to the opposite terminals of said source, and a number n of polarity altering switches connected to said polarity reversing switches, each polarity altering switch being separated from an adjacent polarity altering switch by a polarity reversing switch, the fixed contacts of each polarity altering switch being connected to the output terminals of one of said polarity reversing switches and the movable contacts being connected to the respective segments of the enciphering distributor.

11. In an electrical circuit for producing a train of electrical impulses of varying polarity including a distributor with a number n of segments and a brush rotatable over said segments, the combination of a source of direct current; leads connected to the opposite terminals of said source, a number n of polarity reversing commutator switches in series in said leads, and a number n of polarity altering switches connected to said leads, each polarity altering switch being separated from an adjacent polarity altering switch by a polarity reversing switch, the fixed contacts of each polarity altering switch being connected to the respective leads and the movable contacts being connected to the respective segments of the distributor, said train of elec-

trical impulses appearing at the brush terminal of said distributor.

12. In an electrical circuit for producing at a plurality of terminals trains of current impulses with irregular sequence of the polarity of the succeeding impulses, said sequences being different for each of said terminals; the combination of a source of direct current, leads connected to the opposite terminals of said source, a plurality of polarity reversing commutator switches in series in said leads, the input of the first switch of said series being connected to the opposite terminals of said source, and the input of each of the other switches of said series being connected to the output of its preceding switch, and each individual terminal of said plurality being connected to one of said leads between adjacent polarity reversing switches and being separated from other terminals connected to the same lead by a polarity reversing switch.

13. The combination as set forth in claim 3, wherein said plurality of terminals are grouped in pairs, the terminals forming a pair being connected each to said leads between two adjacent polarity reversing switches, each of said pairs being separated from an adjacent pair by a polarity reversing switch.

14. In an electrical circuit for producing at a plurality of terminals trains of current impulses with irregular sequence of the polarity of the succeeding impulses, said sequences being different for each of said terminals; the combination of a source of direct current, leads connected to the opposite terminals of said source, a plurality of polarity reversing commutator switches in series in said leads, the input of the first switch of said series being connected to the opposite terminals of said source, and the input of each of the other switches of said series being connected to the output of its preceding switch, and a plurality of polarity altering switches, each individual terminal of the respective polarity altering switches being connected to said leads between adjacent polarity reversing commutator switches.

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