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Ciphering and deciphering machines have been built for the direct registration of the text in print; such machines have usually a keyboard, a ciphering mechanism, and a printing arrangement. Usually there are as many communication channels between keyboard and printer, passing through the ciphering cylinders as there are keys, or signs to be ciphered. Where the impulses are transmitted by electricity the ciphering mechanism contains one or several commutators, each with as many ingoing and outgoing contacts which are interconnected in pairs as the number of communication channels. As an example, with a keyboard for 26 letters this would mean twentysix circuits, fed from a suitable electric supply, one contact for each key, commutators with 26 ingoing and 26 outgoing contacts and 26 magnets, where each magnet, if energized, works a type lever. The connections inside the commutators, between in- and outgoing contacts being made in an irregular manner, results in another sign being printed than that which is marked on the key which is struck, and as there is a suitable arrangement provided for the movement of the commutators after striking a key, different letters will be printed even if the same key is struck several times in succession. Apparatus of this kind have the inconvenience of a great number of circuits, contacts, and above all, of complicated commutators.

A simplification has been shown in U.S. Patent 1.663.824 where commutators having only a small number of contacts have been utilized. This has been made possible in the following way: each key when struck closes two contacts. There are two commutators used, and the contacts are so chosen that one circuit is always closed over one of the commutators and the other over the second commutator. If one operates with an alphabet of 25 letters, the commutators will each have 5 sets of contacts, the number of circuits being 10, with five for each commutator, and the number of different combinations being 5 x 5 = 25.

This U.S. Patent has thus shown an important improvement as to the commutators, but has on the other hand complicated other parts: the number of keyboard contacts has doubled in comparison with the earlier electrical cryptographers, and in order to be able to work for example, 25 electromagnets by means of 10 circuits, one must place between the cylinders and the magnets 5 group relays, each with 5 contacts.

The present invention carries the simplification of the working parts as far as possible, as it makes possible the use of the same number of key board contacts as there are circuits, and of the same or even smaller number of magnets.

How this is accomplished, is described hereafter, with due reference to appended drawings, which show a ciphering- and deciphering machine, built according to this invention.

~~(Drawing No. I,) fig. 1, shows a front view and fig. 2 shows a~~

view from above, the cover of the machine being taken off. Drawing No. II, fig. 3, and drawing No. III, figs. 4, 5 & 6, show the main electrical connections, and should be studied together with figs. 1 & 2.

(1) is the frame of the machine, (2) are the keys of the keyboard. When a key (2) is struck, two selector bars (27) are pushed to the left and close two contacts (26'). One contact will always belong to the 5 first circuits and the other to the 5 other circuits. The 5 first circuits terminate at 5 contacts (24) to the left commutator and the 5 other at the 5 contacts (24) to the right commutator. These contacts (24) will in the ciphering position be in touch with the sliprings (23), of the ciphering cylinders (20(. The ciphering cylinders have at one of their ends (those nearest to each other) axially placed contacts (23''), the number of which has been chosen to be ten, which allows ten different positions for the commutators. Two of each of the radial contacts are connected to each of the sliprings. The pedestal (22) between the commutators is made of insulating material, and contains 5 axially placed contacts (21) for each commutator. These contacts are so placed that in any position of the commutator, each contact stands in electric connection with one (different) slipring. Behind the commutators is a bar of insulating material (28'), in which 10 contact sockets (28'') are placed, which are connected with the axial contacts (21). We can now trace the circuits from the contacts (26) to the sockets (28'').

Under the commutators is a switch, the function of which is to reverse the cirquits from ciphering to deciphering, and to allow also ~~to write~~ clear text. ~~The position for ciphering is shown on fig. 3 and coincides also with the position on fig. 8.~~ This switch consists (for each commutator) of an insulating support (25'), ~~on~~ which 5 double-ended contacts (25'') are mounted. These contacts are connected by means of flexible conductors with contact plugs (28), which are placed in the sockets (28''). In fig. 5 these contacts (25'') press against the contacts (23'), which do not touch the sliprings (23) in this position. From the contacts (23') connections are made with the magnets (29). Our cirquits will therefore continue from the sockets (28'') over the contact plugs (28) to the contacts (25'') - (23') to the magnets (29) and will be completed over the battery (26) back to the contacts (26'). Thus when a key is struck, (two) magnets will be energized, and not only the positions of the commutators (20) but also the sequence in which the plugs (28) are placed in the sockets (28'') determine which two magnets (29) are energized each time a key (2) is struck.

It will be found that from the contacts (23') only 8 conductors lead to the magnets, and that the number of magnets is likewise 8, whilst the number of cirquits between the keyboard contacts (26') and the contacts (23') is ten. It will now be shown that while 2 x 5 cirquits give a total of 25 combinations, with the use of one cirquit in each of two groups of five cirquits, the use of eight magnets in two groups of four each will under certain conditions also be equivalent to 25 different movement combinations. ~~It will first be observed~~ that ~~with the wiring shown on fig. 3, the positions of the commutators may~~

be of the following different kinds 1) Each cirquit, begun by a closed contact (26') enters by a contact (24) and leaves by any of those contacts (23'), to which a connection is made to a magnet; consequently here two magnets will be energized, and the number of different combinations of two magnets being 4 x 4 = 16. 2) Only one cirquit, passing through the left commutator will be connected over a contact (23') with a magnet (29), while the other cirquit over the right commutator will arrive at that contact (23'), from which no connection is made with a magnet. Only one magnet, belonging to the group, connected over the left commutator will be energized and we will have four cases, where a different magnet of this group is energized. The same is the case where only anyone of the magnets belonging to the cirquits over the right commutator is energized, making a total of eight different magnet movements, of one magnet energized. 3) There will finally be the case where none of the cirquits, closed by contacts (26') will be completed over a magnet, and giving the resultant: no magnet working. The total will be: 16 different combinations of 2 magnets + 8 ditto of one magnet and one case of no magnet working equal to 25. Before I explain the further functions of the magnets, the different parts, contained in the ciphering mechanism will be described. In order to obtain a great number of different substitutions, two different provisions are made: 1) the 5 x 2 contact plugs (28), which can be placed in $(1x2x3x4x5)^2$ = 14,400 different positions, giving this number of differently arranged electric cirquits. These connections are usually changed only between different messages.

2) The movement of the ciphering cylinders (20), by which either the right or the left or both cylinders (or none) can be rotated one tenth of a revolution between each time a key is struck. This is effected in the following way: The shaft (13) carries four toothwheels (13''), which mesh with four other tooth-wheels (15), which are fixed, each of them together with a key wheel (14). The key-wheels are mounted on the shaft (14''), where they can rotate independently of each other. The number of teeth on the tooth-wheels (13'') is ten, whilst the tooth wheels (15) are all different.

In this apparatus the number of teeth has been chosen - taking the wheels from left to right - to be 23, 21, 19, 17, Fig. 2 i.e. numbers without a common denominator. The key wheels (14) carry near their periphery ~~axially mounted pins~~ a circular row of pins (14'), the number of which is the same as the number of teeth on the tooth-wheels (15), belonging to the key wheels. The keywheels are placed in pairs, and between each pair a tooth-wheel assembly (17) (~~16~~ 18)(17) is mounted loosely on the shaft (13), where it is free to rotate independently of this shaft's movement, The pins (14') can be placed either so that they protrude towards the inside of each key wheel pair, or so that they will not protrude there. The toothed wheels (17) have six teeth each, which will mesh with such pins (14') which protrude. The tooth-wheels (~~16~~ 18) mesh with the tooth wheels (19) which are fixed on the commutators (20). The number of teeth on the wheels (~~16~~ 18) and (19) is so chosen that the commutator (20) will turn 1/10 of a revolution when the assembly (17)(~~16~~ 18)(17) turns 1/6 of a revolution.

When a key has been struck and released again, the shaft (13) will turn 1/10 of a revolution; how this is accomplished will be explained later on. When the shaft (13) turns 1/10 of a revolution, the key wheels (14) will advance one tooth- division each. Where a protruding pin (14') has been in close proximity of a tooth of corresponding tooth-wheel (17), ~~this will~~ that wheel during the movement of the key wheels will be turned 1/6 of a revolution, and the commutator in question will be turned 1/10 of a revolution. In this way either anyone or both or none of the commutators will be turned from one position to the following position between each stroke of a key. As the pins are easily arranged to protrude with irregular intervals, the movement schedule of the commutators will be very irregular, and the same sequence will not be repeated before 23x21x19x17x(10x10)= 15.600.900. strokes have been struck on the keyboard. In order to identify the positions of the key wheels and the commutators, letters are engraved around their peripheries, each key wheel carrying the same number of letters as there are key pins. In the cover, openings are made over the key wheels and commutators, through which the letters can be read. In order to be able to place these wheels in the starting position, chosen or prescribed, the key-wheels can be disconnected by turning the knob (16) after which these wheels and the commutators can be rotated by hand independently of each other until the desired letters show up in the windows.

In order to be able to use the same apparatus for both ciphering and deciphering, a special reversing switch is used, which is operated by means of the knob (25). This switch has already been mentioned: it is placed under the commutators (20). When the insulating support (25′) is in its intermediate position, fig. 4, the commutators are cut out and direct connections are established between the contacts (23′) and contacts (24). Each combination of two closed contacts (26′) will here always result in the same combination of energized magnets (29), i.e. for each key, which is struck always the same magnets will work. This intermediate position is used for writing clear text. The position shown on fig. 5 is as already explained used for ciphering: it should only be stressed, that in this position the cirquit from the contacts (26′) "enters" at a slipring and "leaves" at an axial contact (21). In the deciphering position, see fig. 6, it will be found that the double-ended contacts (25″) on the support (25′) press against the contacts (24) which are thus kept separate from the slip rings (23), while the contacts (23′) press against these slip rings. The cirquit will therefore in this case pass the following contacts; (26′)-(24)-(25″)-(28″)-(28)-(21)-(23″)-(23)-(24). Thus the cirquit will here "enter" the commutator at the axial contact (23″) and "leave" at the slip ring (23), i.e. the opposite as when ciphering.

The printer will be next described: For details of the printer see also fig. 8. The printing is made by means of a typewheel (30), which is mounted on the shaft (9); there is a friction clutch interposed between the shaft (9) and the type wheel (30), so that the type wheel will rotate together with the shaft (9) as long as nothing stops the type wheel. The type wheel carries a double-ended stop arm (40), which is mounted in a support, which is fixed to the type wheel. Around the shaft (9) are placed 25 stop-bars. Each stop-bar has a spring (32) attached to its front bearing, which spring tends to draw it forward. All stop-bars are kept in their indrawn position by a ring (33) which is found at the farther end of the bar cage, and where it presses against notches in the stop-bars. The position of the ring (33) is governed by a cam on the shaft (11) against which a lever, connected to the ring is kept pressed under the tension of a spring.- ~~Around the shaft (9) within the cage there is a~~ hollow shaft, on which 8 selector discs (35) are mounted. The hollow shaft, carrying these discs can have two positions, which are determined by a cam on the shaft (11), against which cam a lever (35'), fixed to the hollow shaft, is pressed under the tension of a spring. When the lever (35') rests on top of its cam, the selector bars can be locked by the pins (38), if the respective magnet (29) is energized: a movable armature is attracted by the magnet core, and the pin ~~(28)~~ 35 is pushed inwards, over a leverage, into a recess in the discs (35). Provision is on the other hand made to allow those discs, which are not locked, to follow the hollow shaft 34, when its cam 111 on the shaft (11) is in a position which allows the lever (35') to be drawn downwards nearer the shaft center (11), by tension of the spring 340; also to return to the original position when the cam 111 forces the lever (35') back in its topmost position. The selector discs (35) are provided with teeth, and the stop bars (31) with notches, arranged in such a manner, that when one of the 25 different magnet movement combinations is made, and when the hollow shaft is turned by means of the lever (35') and its spring, allowing those selector discs (35), which are not locked by the pins (38) to follow the movement of the hollow shaft and when the ring (33) is released, only one of the 25 stop bars (31) will be free to be drawn forward by means of its spring (32), all other stop bars (31) will be retained by some tooth of one or several of the selector bars (35). A schedule for the teeth on the selector-discs is shown on fig. 24. - Thus for every one of the 25 different movement combinations there will be a different one stop bar which will move forward.

A stop bar having moved forward, comes with its forward end into the path of the stop-arm (40) of the type-wheel (30) and causes it to stop. The printing is done on a paper tape (42''), which is fed from a magazine (42) on the left side of the machine. It is led over the guard (41), inside which the impression hammer (44) is located. From the guard it passes a feeding arrangement, consisting of a roller (42') against which the paper tape is pressed by means of a friction roller (43). On the type wheel the types of the letters and signs to be printed are so placed, that when a stop bar, representing a certain letter has stopped the type wheel, the type in question will be found opposite the hammer (44).

The shaft (11) carries properly profiled cams for the operation of the hammer (44) and also for the working of the paper feed, which is done over the lever (45') the ratchet (45) and the ratchet wheel (42''). This shaft (11) governs the printer as well as the movement of the shaft (13) of the ciphering organs.

The power for the operation of this shaft (11) and for the rotation of the type wheel (30) is obtained from the motor (3), which drives the shaft (9) over a reduction gear (8). In emergencies, when there is no current available, the motor can be turned by a crank (4) over a gearing (5), which can be connected to the motor shaft by means of the clutch (7), by tightening the screw (6). The current is switched on or off over the switch (3').

When the motor runs, the shaft (9) rotates, and also the tooth-wheel (10), which meshes with the wheel (9') on the shaft (9). The wheel (10) is mounted on a shaft, which extends into the clutch assembly (12), the outside part of which is rigidly fastened to the shaft (11).

There extends under all key bars a common clutch trip bar (12'). When a key is struck, this bar (12') is pressed down, and by means of a leverage (12''), the clutch (12) is tripped, and the shaft (11) starts to turn. Means are provided so that the shaft (11) will make only one complete revolution, each time a key is struck. During this revolution, the following happens: the type wheel will be stopped — and a letter printed, the paper tape will be fed one step and the shaft (13) will be turned 1/10 of a revolution, causing one or both or none of the commutators to advance one step.

In order to make the reading of the cipher and also the checking of the number of signs ciphered easier, provisions are made for intervals between groups of letters, suitably after every 5 letters printed. The number of strokes, struck on the keyboard is registered by the counter (16'). Further provisions are made to allow the ciphering, not only of letters, but also of figures, other signs and spaces between words. In order to accomplish this, the type wheel carries not only type for the letters but also for the figures and signs chosen. The machine, described here, has been arranged for the ciphering of 25 letters, there being 25 different combinations when using two commutators for 5 circuits each. One may however make every combination have two meanings, for example a letter and a number, in much the same way as on a typewriter, where a key may be marked with both a letter and a figure, and the respective typebar carries the two corresponding types. Which one is to be printed is determined with the help of a shift key. In order to obtain spaces, a space key is used. When ciphering, it is not desirable that it should be understood by outside parties when "shifting" is done, nor where the intervals between the words are to be found. Therefore it has been deemed suitable to cipher the "shift" and "space" signals, in exactly the same way as the proper text is ciphered, and to provide the printer with such means, which accomplish that "shifting" and "spacing" will be made automatically when deciphering. This means that as certain variable letters in the cipher stand for "shift" and "space", the combinations of the magnets working from the circuits made when deciphering these letters must work the shift or the space instead of printing a letter.

As we use each of the 25 combinations for two different meanings, we will have a total of 50 different letters and signs which can be ciphered. For convenience, they will be divided in two series (of 25 signs each). In the first series we place 23 of the most frequent letters. The two remaining places are occupied by the combination used for the space between signs of the 1st series i.e. between words, and by the combination indicating that the following signs ciphered belong to the second series, i.e. the "shift".

In the 2nd series we place the remaining letters, the numbers, some of the punctuation signs and the most used abbreviations, and necessarily also the space between signs of the second series and also the shift back to the first series, i.e. the "reshift".

On the type wheel the types of the signs of the 2nd series are placed diametrically opposite those of the 1st series.

As the stop-arm (40) is double-ended, and can take two positions, so that either of the ends will protrude so far that it will strike against a liberated stopbar (31), either a sign of the 1st or a sign of the 2nd series will be printed, depending on the position of the stop-arm (40).

In order to govern the position of the stoparm and to move it automatically from the position of the 1st to that of the 2nd series of signs, the following arrangement is made: On the side of the stop-bar cage nearest to the shaft (11) a moveable assembly (50) is mounted carrying at its forward end a crescent shaped steel plate (51'); the edge toward the stop arm, forms a guide for the ends of the stop-arm. When the typewheel rotates, that end of the stop-arm, which protrudes most will first strike that part of the plate (51') which is farthest from the centre of rotation and will, when it has left the plate, have been forced inwards, so that instead the opposite end of the stop-arm will protrude most. The two ends of the stop-arm lie in slightly different planes of rotation, and the plate (51′) can occupy two positions, so as to be either in the plane of the stop-arm end for the 1st series of signs or so as to be in the plane of the 2nd series′ stop-arm end. Thus, if the plate (51′) is in the plane of the 1st series, that end of the stop-arm will be pushed inwards, and the 2nd series′ stop-arm end will be pushed outwards, and vice versa. In order to effect the movement of the plate assembly (51′) at the appropriate moment from one position to the other, the following arrangement is made: The stop bar (31) immediately above the plate assembly (51′) is liberated when the magnet combination for the "shift" works. This bar has an abutment (48), which when moving forward, strikes against the upper end of a lever, which is mounted vertically in the bearing fork (47). ~~This lever is connected with a rod to a switching mechanism,~~ which is worked from a cam (51) on the shaft (11). When the lever is struck, the switching mechanism is tripped, and the plate assembly (51′) is pushed over to the other position, and consequently the rotating stop-arm will also be pushed over from one position to the other. The stop bar (31) underneath the plate assembly (51′) also carries an abutment, and this bar is liberated when the magnet combination for the "reshift" works. Then the abutment strikes at the under end of the tripping lever, and the cam (51) causes the plate assembly to move to its first position, and in its turn push back the stop-arm. As neither a letter should be printed nor the paper tape be fed forward during the shifting and the reshifting operating, a blocking lever (56) is provided for this purpose. A cam on the shaft (11) and a spring cause this lever to make an intermittent swinging movement just before the hammer (44) strikes and before the paper feed lever swings back. If the type wheel has been stopped by a shift or reshift stop bar the nose (56′) of the lever (56) will be stopped by a pin (57′) on the side of the type wheel, and abutments on opposite end of the lever will block the hammer and the paper feed lever.

In such cases, where a stop bar is liberated by a magnet combination which is equivalent to a space sign, the nose (56′) of the lever (56) will swing against a pin (57), which is situated a little farther towards the centre of the type wheel. In this position only the hammer will be blocked and the paper will be fed, leaving a blank space. For all other stop bars the lever (56) will swing its full way, and the blocking abutments will pass their respective blocking positions, and both the hammer and the feed lever will be free to work.

When ciphering, however, all the 25 stop bars are utilized for stopping the type wheel and for printing any one of 25 cipher letters. ~~The knob (25) is connected by means of rods (53) & (54) and levers (53) with the lever bearing (47)~~. When the knob (25) is in the ciphering position the ~~bearing~~ (47) is swung out of the position, where the abutments (48) engage with the tripping lever. There is also a blocking lever (55) which is loosely mounted on the shaft (11), which blocks the lever (56) when ciphering. Thus when the bars for shifting or reshifting, or for space (when deciphering) are liberated, there will be no shifting and both printing and paper feeding takes place.

In order to obtain an extra space automatically between a group of 5 letters, when ciphering, there is a spacing mechanism. This works from the shaft (13), where there is mounted a cam (46'), which has two diametrically opposed depressions. One end of a lever (46) is pressed by means of a spring 46" against this cam. ~~The~~ other end of this lever extends closely against the ratchet (45) of the paper feed. On this ratchet there is an abutment, so placed, that when the spacing cam on the shaft (11) allows the ratchet to be drawn by its spring backwards, the ratchet will be stopped against the end of the lever (46) when it has moved backward the length of a tooth on the ratchet wheel (42''). When it is then pushed forward by means of the cam and the lever (45'), the paper tape will be fed just one space, i.e. the normal distance between letters. For every fifth letter printed however, the farther end of the lever (46) will recede into a depression of the cam (46'), and the other end of the lever will no longer stand opposite the abutment on the ratchet (45). This will then be free to move back the full amount of the movement, given from its cam which is made to be equal to the length of two teeth on the ratchet wheel (42''). Thus, after every five letters a double spacing will be obtained. As this automatic spacing is not desirable when deciphering, the lever (46) will be blocked by an abutment, on the leverage (52) which is worked from the knob (25).

After having described one way to realize my invention, I will show that the same principle is workable also if the number of ciphering cylinders must not necessarily be two. I refer to figs.

10, 11 & 12, where diagrams are shown for an apparatus for three ciphering cylinders, each having 3 channels. When a key (2) is struck, one bar (27) of each of the three groups of bars is pushed to the right and closes three contacts, one within each group. The three circuits pass through the cylinders (59) and energize three magnets (29). The circuits are completed through the battery (26). The printing mechanism is analogous to that of the apparatus, described in detail. Here it carries 9 selector discs (35), which can be locked by the pins (38), and of 27 stop bars, the selector discs being so made that for the 27 different combinations of three energized magnets, one within each of the three groups, a different stop bar will be released, and a different letter will be printed. Fig. 12 shows all the possible different inside connections of a ciphering cylinder for three channels.

The ciphering may also be made through purely mechanical means, without departing from the principle of this invention. See figs. 13 and 14. Here two ciphering cylinders for three channels, for the ciphering of 6 signs, are represented by (61). These cylinders carry projections, for three different heights, the bars (27) carry, each of them a bar (60) which has a nose at the other end pointing downwards. The nose of each bar will rest on a projection (61) when the bar lifter (63), which is common for all bars, is depressed. The levers (64) are analogous to the pins (38) on fig. 11. There are two groups of three levers (64) each, and each carries a projection at a different height, and so arranged that the bar (60), which rests on the lowest projection (61) of the ciphering cylinder will come opposite the lowest placed projection of the levers (64) etc.

Thus, when a key (2) is struck, two bars (27) will be pushed to the right, and the respective bars (60) will also move to the right. Then, depending on which levels these three bars lie, which is determined by the projections of the ciphering cylinders, any one of the three levers (64) within each group of two levers will move also and lock its respective selector disc, and will allow the printing of the letter which answers to this combination of locked discs. To allow the movement of the cylinders from one position to the next, the ~~rods~~ bars (60) are lifted by means of the lifter (63) after each time a letter is printed.
