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Cryptograph

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An object of this invention is to provide a cryptographing machine which, when properly positioned over the keyboard of any commercial typewriter, will function to transform an intelligible message being typed on the keyboard of the cryptographing machine into an unintelligible or cipher message on the typewriter over which the cryptographing machine is positioned. The production of the cryptogram will be automatic and require no special cryptographic skill or knowledge on the part of the operator, he being ignorant of any particular letter which will occur as a resultant of the action of the cryptographing machine upon the typewriter. This cryptogram may then be sent by any of the usual commercial methods; mail, telegraph, cable, or radio, and will be unintelligible to persons without the proper means of decipherment. A person provided with a cryptographing machine identical with the one used to encipher the message, and with the key applicable, simply rewrites the cryptogram, letter for letter, on the keyboard of his cryptographing machine, which produces the legible message on the typewriter with which it is in operative relationship.

A further object of this invention is the provision of the unique means by which a key of the typewriter keyboard is selected and is then struck to print the cipher or deciphered letter..

A further object and novel feature of this invention is the indirect control of the keyboard of a standard typewriter by the resultant action of a plural-unit-code tape transmitter upon a plural-unit-code keyboard transmitter.

The many applications of such a device as an automatic cryptographing machine which can be used with any or all commercial typewriters, requiring only to be positioned over the keys of the typewriter and removed as desired, will be readily apparent. Any com-

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mercial or military office in which secret communication is requisite can employ such a device without requiring the costly and tedious labors of trained cryptographers.

In the drawings accompanying and forming a part of this application Figure 1 is a schematic representation of the cryptograph in its relationship to a typewriter keyboard; Figures 2, 3, and 4 show it in its mechanical details.

It is believed that an explanation of a schematic representation of our invention will form the best basis for its understanding, and therefore reference will be made to Figure 1. In this figure A represents a front view and D a side elevation of a Baudot keyboard transmitter; B represents a perforated-twpe transmitter; C represents a front view, and E a side elevation of a Baudot slotted-bar translator; F represents a side elevation of the keyboard of any typewriter G, bearing the standard keyboard.

The Baudot keyboard transmitter is so well known in the art of printing telegraphy that no detailed description of it is deemed necessary. It is sufficient to indicate that we make use of a standard six-bar transmitter, the bars being designated 0, 1, 2, 3, 4, 5. The bar 0 acts as a "universal bar" and serves a function to be described presently. The function of bars 1 to 5 is to control the set of contact levers 6, 7, 8, 9, 10. These contact levers are normally at the left, but when a bar, for example 3, is displaced toward the right by depressing a keybar 121 of the keyboard transmitter A, the contact lever 8 is moved to the right and closes contact at 16. The five contact levers being independent, it is obvious that the contacts controlled by them can be established in a permutative manner to correspond to the permutations of marking and spacing elements of the well known Baudot five-unit code. The letter A, for example, is represented in this code by the symbol + + --- where a " + " indicates

a marking element, a "-" indicates a spacing element. For our purposes, a "+" will indicate that the transmitter bar has moved to the right and that the contact lever is making contact with its right hand contact; and a "-" will indicate that the transmitter bar has not moved and that the contact lever is making contact with its left hand contact. Thus, as we have arranged it, contact of the levers 6, 7, 8, 9, and 10 is made with their left contacts 11, 13, 15, 17, and 19, respectively, when no displacement of the bars takes place, and contact of the levers with their right contacts, 12, 14, 16, 18, and 20, respectively, is made when the bars are displaced. Therefore, the contacts set up to correspond with the Baudot code for letter A will be as follows: contact lever 6 closing contact 12; contact lever 7 closing contact 14; contact levers 8, 9, and 10 remaining against contacts 15, 17, and 19, respectively.

Transmitter bar 0, is, as stated, a universal bar, and has as its function the control of contact 36, which, in conjunction with back contact 37 of a relay 38, controls a magnet 50 that is a part of translator C. The circuit and function of magnet 50 will be explained later. Contact 36 is closed on the depression of any keybar.

A master contact 39 of A, under control of a universal bar 46, serves to keep the entire system in an inoperative condition until any key of keyboard transmitter A is depressed. A tooth at the right extremity of each bar 0, 1, 2, 3, 4, and 5, will move universal bar 46 to the right and will thus close contact 39 when any one of the bars is displaced to the right. It is necessary that the sliding bars of the keyboard transmitter A be locked into the positions they assume on the depression of a key until all the subsequent operations and functions have been completed. This is accomplished by means well known in the art. A locking bar 48, controlled by armature 49 of magnet 56 is brought up against one side or the other of lugs projecting from the underside of the transmitter bars, so that a bar that has been displaced to the

right cannot move back into its neutral position, nor can a bar that has retained its neutral position be displaced to the right until the locking bar has been released. The electrical current for locking magnet 56 is as follows: from positive of battery H through conductor 91, contact lever 83, closed contact 84, conductor 92, closed contact 39, conductor 96, winding of magnet 56, conductors 97, 88, and 87, to negative of battery H. Spring 98 holds armature 49 in its unactuated position. The principal parts of the keyboard transmitter A have now been described.

The tape transmitter B is also so well known in the art of printing telegraphy that no detailed description is necessary. Suffice it to say that it has five contact levers 21, 22, 23, 24, and 25, which vibrate between five right-hand or marking contacts 27, 29, 31, 33, and 35, and five left-hand or spacing contacts 26, 28, 30, 32, and 34, under the control of a perforated tape, by means of five finger pins, not shown, which are present under the tape. As in the case of the keyboard transmitter the right-hand contacts are in our terminology "-+-" contacts, the left-hand ones, "-" contacts. Upon the presentation of a hole in the tape over any of the finger pins the act of the pin rising through the hole allows the pertaining contact lever to move to its right hand contact and therefore makes that contact one that can be designated by the "-+-" sign. When the pin does not go through a hole in the tape the contact lever makes contact with its left-hand contact, and therefore this can be designated by the "-" sign. The tape is perforated to correspond to the permutations of the Baudot code, and thus there are 32 different permutations of contact levers of B. The finger pins are withdrawn and the tape is stepped forward automatically by magnet 47, after the transmission of the impulses corresponding to the set of -+- and — contacts denoting a given letter of the Baudot code. Supposing the perforations denoting the letter N, whose code equivalent is "- - -+- -+- -", be presented to the pins of B, contact levers 21, 22,

and 25 will be against their left-hand contacts 26, 28, and 34, respectively; contact levers 23 and 24 will be against their right-hand contacts 31 and 33, respectively. The principal parts of the tape transmitter B have now been described.

The Baudot translator C is also well known in the art of printing telegraphy. It consists of the usual set of five notched bars 41, 42, 43, 44, and 45, and one additional bar, 40, whose function will be explained later. The five bars 41 to 45 are displaced to the right under the control of the set of magnets 51, 52, 53, 54, and 55. These magnets are controlled jointly by the sets of contacts of the keyboard transmitter A and the tape transmitter B in a manner well known in the art of printing telegraph cryptographs, so that a brief description will suffice. The electrical principle, in brief, is that the circuit through any of these can only be completed when the controlling contact lever in the tape transmitter is in non-homologous position as regards their left and right contacts. Thus, in Figure 1, consider magnet 51 of C, the circuit of which is controlled by the two contact levers, 6 of A, and 21 of B. Only one of four possible cases with respect to these contact levers can exist at a given moment:

Case 1 Contact lever 6 makes contact at 11
Contact lever 21 makes contact at 26

When this is the case the circuit for magnet 51 is open. Thus, from positive of battery H through conductor 91, contact lever 83, closed contact 84, conductor 92, closed contact 39, conductor 99, contact lever 6, contact 11, conductor 86 to contact 27 which is open, and hence magnet 51 cannot be energized.

Case 2 Contact lever 6 makes contact at 11
Contact lever 21 makes contact at 27

When this is the case the circuit as traced directly above remains the same up to the condition of contact 27. This now being closed the current can continue through contact lever 21,

conductor 100, winding of magnet 51, conductors 105, 106, resistance 60 and relay 38, conductors 107 and 108 to negative of battery H. Magnet 51 is therefore energized.

Case 3 Contact lever 6 makes contact at 12
Contact lever 21 makes contact at 27

The circuit as described for the two preceding cases is the same here up to contact lever 6, which now being against contact 12 the current continues along conductor 61 to contact 26 which is now open. Hence magnet 51 remains unenergized.

Case 4 Contact lever 6 makes contact at 12
Contact lever 21 makes contact at 26

The circuit under case 3 can now be completed, from contact 26 through contact lever 21, conductor 100, and thence, by path described under case 2, to negative of battery H. Hence, magnet 51 is energized.

It is thus seen that when the homologous governing contact levers are in similar positions no circuit is established through the pertaining magnet of G; only when one contact lever is at the left or minus sign contact, and the other is at the right or plus sign contact will the circuit be completed. It is immaterial which lever is making the plus contact, which the minus contact.

As said before, magnet 51 has four companion magnets, 52, 53, 54, and 55, the circuits for which are similar in character to those described for magnet 51, but are all independent of one another in the control of their respective magnets.

The armatures of magnets 51 to 55 are yoked to translator bars 41 to 45, respectively. When any one of the magnets 51 to 55 is energized it draws the bar to which its armature is yoked to the right and holds it there until, when the circuit through the magnet is broken, a retractile spring at the left extremity of the bar brings the latter back into its normal position.

The various permutative positions assumed by the translator bars of C, Figure 1, determine the selection of the letter to be printed by the typewriter. These bars are slotted, the slots being so arranged that, as the bars are displaced to the right under the action of magnets 51 to 55, there will be for each different permutative arrangement of the translator bars one and only one alignment of slots presented under the set of stunt bars 109, into which a particular stunt bar can drop, being pulled by a spring attached to one extremity of the stunt bar. (Side elevation E shows one spring, 122). The stunt bar selected is not permitted to drop into the alignment of slots until a universal bar 110 of C(110' of E) is released under the action of a magnet 57 of E, circuit for which is closed by contact 58. This contact 58 is operated by a bar 59 which is displaced to the right when any of the translator bars 41, 42, 43, 44, 45, or the extra bar 40 is pulled to the right. The circuit for magnet 57 is as follows: from positive of battery H through conductor 91, contact lever 83, closed contact 84, conductor 92, closed contact 39, conductor 116, winding of magnet 57, conductor 117, closed contact 58, conductors 86, 108 to negative of battery H.

When any stunt bar 109 of C (109' of E) drops into position it strikes a crank shaft 114 of C (114' of E) which closes a contact 115 of E. This contact controls the printing magnet 73, whose armature 74, which swings about an axis 75, actuates the printing drive pin 76. The circuit for magnet 73 is as follows: positive of battery K, conductor 118, winding of magnet 73, conductor 119, closed contact 115, conductor 120 to negative of K. In practice batteries K and H are the same, being here shown as separate only clearness of circuit tracing. Also the batteries are simply to represent a source of E.M.F.; either machine or battery for the equipment can be designed for a range of voltages.

When a stunt bar drops into position it draws down with it

drag link 77 presenting the slot in member 78 before the printing drive pin 76. When magnet 73 is energized, member 78 is driven forward operating drive bar 79 by bell crank action about shaft 80. Drive bar 79 in turn operates a plunger 81 which actuates the proper key of keyboard F of typewriter G. When drive bar 79 is practically at the bottom of its stroke it operates crank 82 thereby moving contact lever 83 from contact 84 to contact 85. This action causes two things to happen: (1) The tape step forward magnet 47 in tape transmitter B is energized, the circuit being from positive of battery H through conductor 91, contact lever 83, contact 85, conductor 90, winding of magnet 47, conductors 89, 88, and 87, to negative of battery H; (2) When contact 84 is opened the entire system is restored to normal in the following manner: circuit for lock magnet 56 is broken at contact 84, thus releasing the transmitter bars of A and in turn opening master contact 39. When the latter contact opens, the circuit for universal bar magnet 57 of translator C is broken, the return of the universal bar 110 of C (110' of E) under action of spring 71 raising the selected stunt bar 109 of C. Thereupon the translator bars of C return to normal. Crank contact 115 is opened when the selected stunt bar comes out of the slots, print magnet 73 is deenergized, armature 75 is retracted by spring 123, and print bar 79 returns to normal. The latter releases crank 82, contact lever 83 is restored to make contact at 84, and the entire system is now in readiness for another operation.

There now remains to be explained the function of magnet 50 of C and its associated parts and circuit. For the purposes of our invention it is essential that the typewriter G [illegible] some record for each and every depression of the keybars of the keyboard transmitter A. A consideration of the functioning of magnets 51, 52, 53, 54, and 55 will show that when the permutative arrangement of the contact levers of keyboard transmitter A is identical with that of the contact levers of tape transmitter B, none of the magnets 51, 52, 53, 54, or 55 will

be energized. In other words, whenever the Baudot combination set up on A is the same as that set up on B, the resultant is zero, or "blank". It is necessary that the cryptograph make a record of each such case in order that messages may be correctly deciphered. The details of the method we have devised for this recording follow.

As already explained, the circuit for magnet 50 is completed only when keyboard contact 36 is closed and at the same time the armature 72 of relay 38 is at its back contact 37. Contact 36 closes each time any key of transmitter A is depressed, under action of transmitter bar O, but contact 37 is closed only when none of the magnets 51 to 55 is energized. That is, whenever the resultant of the interaction of transmitters A and B is anything other than zero or "blank", relay 38 is actuated and contact 37 is broken. That relay 38 will be energized every time that any resultant whatever except "blank" is set up at magnets 51 to 55 is obvious from the position of relay 38 in the circuits for these magnets, since in order to reach the negative terminal of battery H, the current through all these magnets must flow through relay 38. The reason for the parallel combination of resistance 60 and relay 38 is so that a fairly sensitive relay may be shunted by a resistance of such value that the voltage drop across the combination will not be great enough to interfere with the satisfactory operation of magnets 51 to 55, whether only one operates or whether they all operate. It is necessary that relay 38 be interposed between battery and magnets 51 to 55, but it is optional whether a low resistance relay is used or a high resistance relay shunted by a low resistance unit. When, however, the resultant is "blank", then and only then will contact 37 remain closed and magnet 50 energized. The circuit for magnet 50 is then as follows: from positive of battery H through conductor 93, winding of magnet 50, conductor 94, closed contact 36, conductor 95, contact lever 72, contact 37, conductor 87 to negative of battery H. The armature of magnet 50 is yoked to the sixth translator bar, 40, which, like

the other translator bars, is drawn toward the right when magnet 50 is energized. Translator bar 40 determines the selection of a stunt bar which in turn causes the printing of a character. In the position shown as occupied by the stunt bar referred to the character printed will be "½", according to the keyboard of a standard typewriter, but it can, of course, be caused to print another, a dash for example.

It has been seen that there is no direct relation between the keybar struck on the keyboard transmitter A and the letter that is printed on typewriter G. The relation is only an indirect one, exercised by the tape transmitter B, and specifically by the particular Baudot combination that happens to be set up at B at a given moment. If the perforated tape passing through B consists of perforations representing an entirely random, unintelligible sequence of letters it obviously becomes an enciphering key which may be employed to transform an intelligible communication into an unintelligible one that will be secret to all except those possessing the key. Since the tape advances automatically after each printing operation, the enciphering key changes with each letter to be enciphered, and this can be extended indefinitely by making the pefforated tape as long as the text to be enciphered.

It will now be assumed that the keybar for letter A is struck on the keyboard transmitter A, and that at the same time the finger pins in tape transmitter B are set up according to the Baudot code for letter N. From what has been said in connection with magnets 51 to 55 it will be clear that the resultant of the interaction of these two letters will be as follows:

Keyboard transmitter	=	+ + − − −	=	A
Tape transmitter	=	− − + + −	=	N
Translator	=	− + + + −	=	K

Translator bars 41, 42, 43, and 44 will be drawn to the right under the action of energized magnets 51, 52, 53, 54, the electrical circuits for which are deemed sufficiently well understood from the foregoing description to warrant their tracing being omitted.

The K stunt bar will be the one selected and will drop into the aligned slots on the translator bars upon the energization of the universal bar magnet 57 by closing of contact 58. When the K stunt bar drops into position drag link 77 draws member 78 down, presenting its notch before printing drive pin 76; the K stunt bar also causes crank contact 115 to be closed and print magnet 73 is energized, causing print bar 79 to be driven down, depressing the K plunger, 81, and causing the typewriter G to print the letter K. At the end of the downward stroke of bar 79, crank 82 opens contact 84 and closes contact 85. The results of the operation of the crank 82 have already been set forth, the entire system being cleared and made ready for the next cycle.

Assuming that we have been dealing with a case of enciphering, wherein A is the plain-text letter, N, the key letter for enciphering A, and K the resultant cipher letter, the decipherment requires that the depression of keyboard K on the transmitter A, combined with the setting up of letter N on tape transmitter B, shall produce A, the original plain-text letter. The interaction may be shown schematically as follows

Cipher letter K	=	+ + + + −
Key letter N	=	− − + + −
Plain-text letter A	=	+ + − − −

In this case only magnets 51 and 52 would be energized, the A stunt bar selected, and A printed on the typewriter G. Thus, the reciprocal relationship between the plain-text and cipher letters through the intermediacy of the key letter N has been maintained.

We may now proceed to a description of the apparatus in its mechanical aspects. Figure 2 is a side elevation view of the cryptograph in its relationship to a typewriter keyboard. The side frame of the cryptograph is shown removed, for the sake of clearness. In this figure the protion denoted by A is the cryptograph, and B denotes the keys of the typewriter. The keybars, 1, are pivoted on a common shaft, 2, and are held up by individual springs, 3. The keybars operate the transmit-

ter bars, 4, which are supported at their extremities by ball and roller bearings. The mechanism for locking the transmitter bars into position is shown as consisting of magnet 5 whose armature 6, normally held by spring 7, when attracted causes bar 8 to rock on pivot 9 and lock the bars into position. Magnet 10 is one of the set of six translator-bar magnets, the other five being behind the one shown, each equipped with an armature, 11, bell crank, 12, and coupling, 13, for moving the translator bar controlled by it. The translator bars themselves are shown at 14. At 15 is shown but one of the set of 32 stunt bars, the others being behind it. The stunt bars are pivoted at 16 and are pulled into an alignment of slots on the translator bars 14 under the action of individual springs, 17. Each stunt bar is provided with a drag link, 18, which is coupled to a member, 19, at pivot pin, 20. Member 19 is provided with a slot 21 and is pivoted and coupled to print bar 22 at pin 23. Print bar 22 operates with a bell crank action about shaft 24 which is common to all the print bars. When member 19 is drawn downward by the action of a translator bar, 15, upon drag link 18, it presents its slot 21 before the drive pin 25, which is common to and runs under all the slotted members of which 19 is but one. Drive pin 25 is under the control of print magnet 26, whose armature27, held neutrally by the pull of spring 28, rocks upon pivot 29. When magnet 26 is energized its armature 27 causes drive pin 25 to engage slot 21 and strike that member 19 which has been presented to the drive pin, causing print bar 22 to be driven downward upon plunger 30. Plunger 30 and all other print plungers have common bearings at 31 and are held up in normal position by springs such as 32 under pin 33. When the plungers are driven downward their feet, 34, strike the pertaining typewriter keys of B. When print bar 22 has almost reached the end of its downward stroke it operates crank 35, which is crank 82 of Figure 1. This crank is common to and runs underneath all the print bars, and only one of its bearings is shown at 36. As explained in connection with Figure 1,

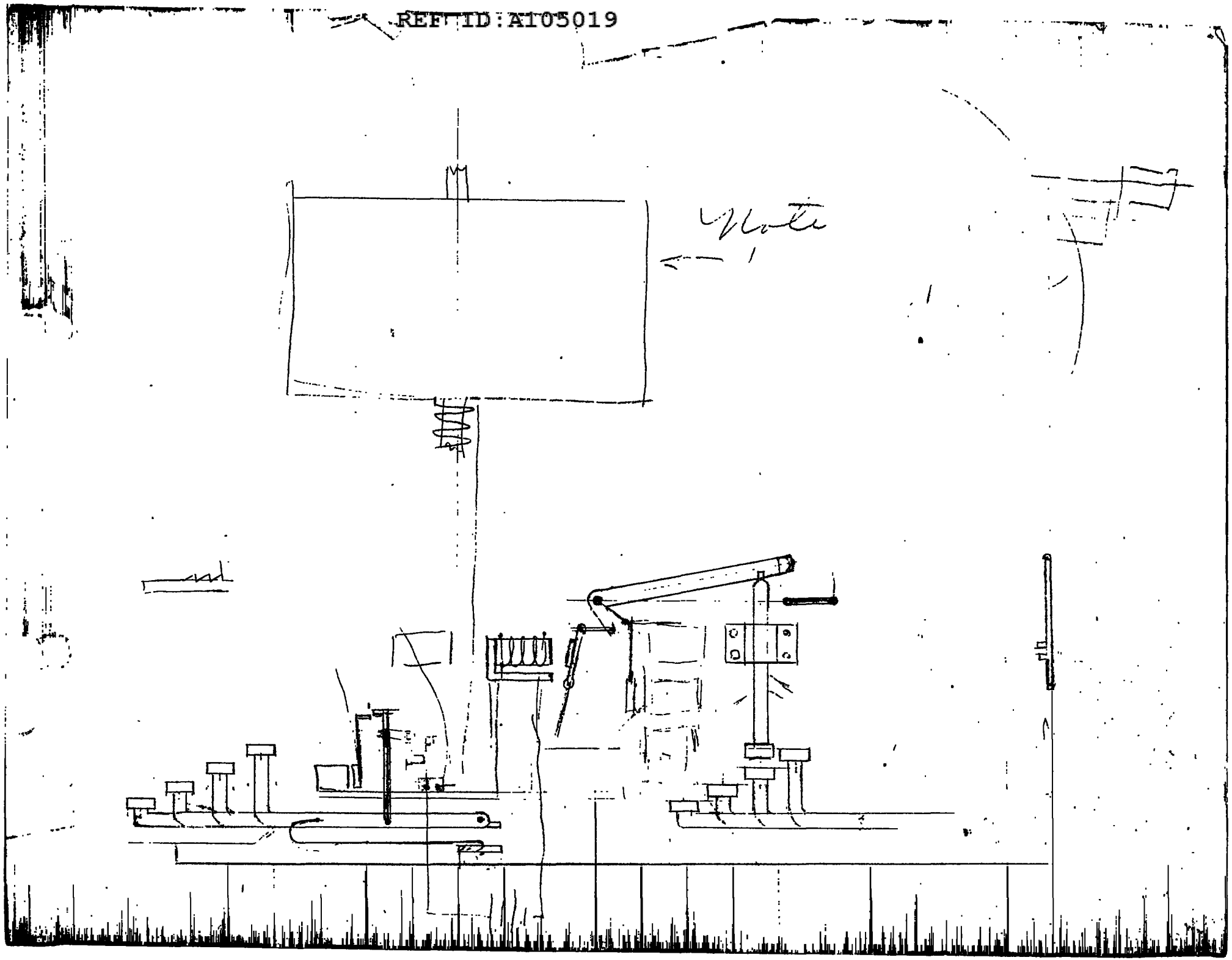
the function of this crank is to close the circuit for the tape-stepping magnet 47 of Figure 1, as well as to open the circuit of the transmitter-bar locking magnets 56 of Figure 1, two operations which are necessary to restore the machine to normal. At 37 is shown a crank which corresponds to crank 114 of Figure 1, and controls the contact for the print magnet 26 of Figure 2, 73 of Figure 1.

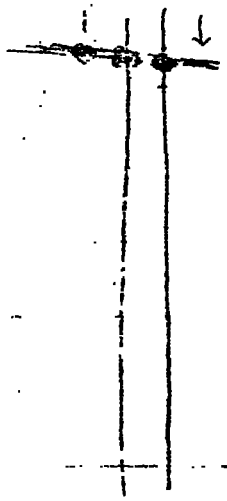
Figure 3 is a front view of the cryptograph, in which the keys of the keyboard are designated 1. Only one of the set of transmitter bars is shown, this being the foremost one, designated 2. The manner in which the transmitter bars control their contacts is shown for this bar, wherein it is noted that the bar is yoked to contact lever 10, operating the latter about axis 8, thereby presenting contact lever 3 to either contact 4, when the bar is at its normal position to the left and hold there by spring 9, or to contact 5, when the bar is displaced to the right upon depressing a key which causes this bar to operate. Proper terminals for wiring are arranged for on the insulating supports 6 and 7 as shown at 14 and 15 for the front and back contacts and at 13 for the lever contact by coiled wire 12, it being understood that the lever contact is insulated from the frame at 11. The other five transmitter bars are directly behind the bar 2, each controlling identical contacts, all of which are mounted on the insulating supports 6 and 7. Behind this set of contacts is the master contact 39 of Figure 1. In Figure 3 only the crank 27 which controls this contact can be seen, but this member and its contact are shown in detail in Figure 4, which will be discussed later. A shelf, 19, is provided for placing the tape transmitter (B of Figure 1) into position. The tape transmitter is usually in compact form with nine terminals for external electrical connections. At 16 is shown one of the nine spring clips, equally spaced and mounted upon an insulating block 17 for soldered electrical connections at 18. The nine terminals of the tape transmitter fit under the nine spring clips. A dust cover for the shelf

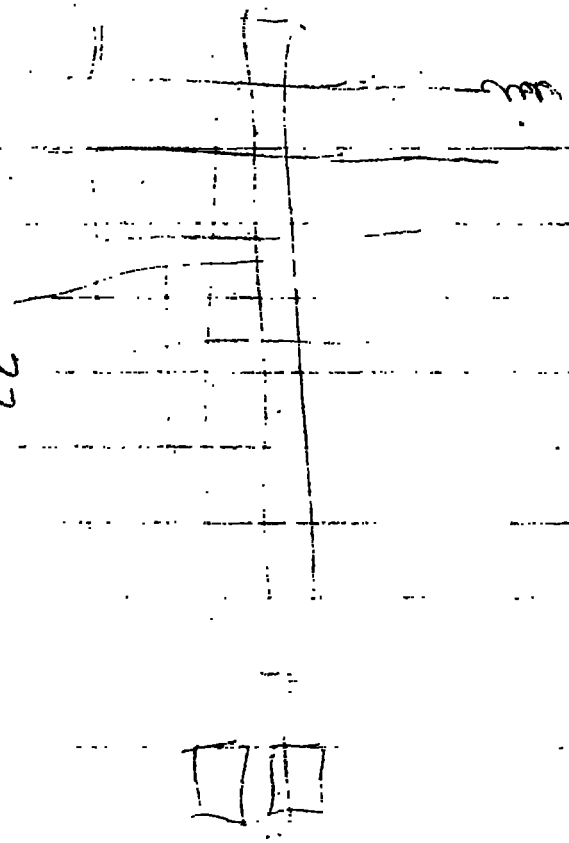
19 is provided. At 20, 21, 22, 23, 24, and 25 are shown the six translator-bar magnets which actuate the translator bars, of which only one, 26, is shown. In this figure only the ends of the stunt bars 28 are visible. They are connected to drag links 40, and at 41 are shown the print bar slotted members (21 of Figure 1), at 42 are shown the print bars. At 43 is shown the crank (114 of Figure 1, 37 of Figure 2) which operates the contact 29 (115 of Figure 1) controlling the print magnet 30, Figure 3 (75 in Figure 1 and 26 in Figure 2); pin 31 is provided with bearings 32 and 34 pivoted on common centers 33 and 35. It will be seen that drive pin 31 runs across the machine and under all the slotted members 41. At 37 is shown the crank corresponding to crank 82 of Figure 1, 35 of Figure 2. Crank 37 also runs across the machine and under all the print bars 42, the crank being pivoted at common centers 38 and 39. At 43 is shown the transmitting-bar locking mechanism

Figure 4 shows the arrangements for the master contact 39 of Figure 1 as associated with the keyboard transmitter contacts. In Figure 4 the transmitter bars 0, 1, 2, 3, 4, and 5 are shown in relation to the contact levers of which only three, 7, 8, and 9 are seen; contact lever 7 makes contact at 10 when the bar 1 is in its normal position and held so by spring 6, or at 11 when the bar is displaced to the right. Two terminals 12 and 13 for soldered connections are shown. The crank 14, pivoted at 15, operates contact lever 16, closing contact 17 whenever one or more of the bars are displaced to the right.

We claim:







32

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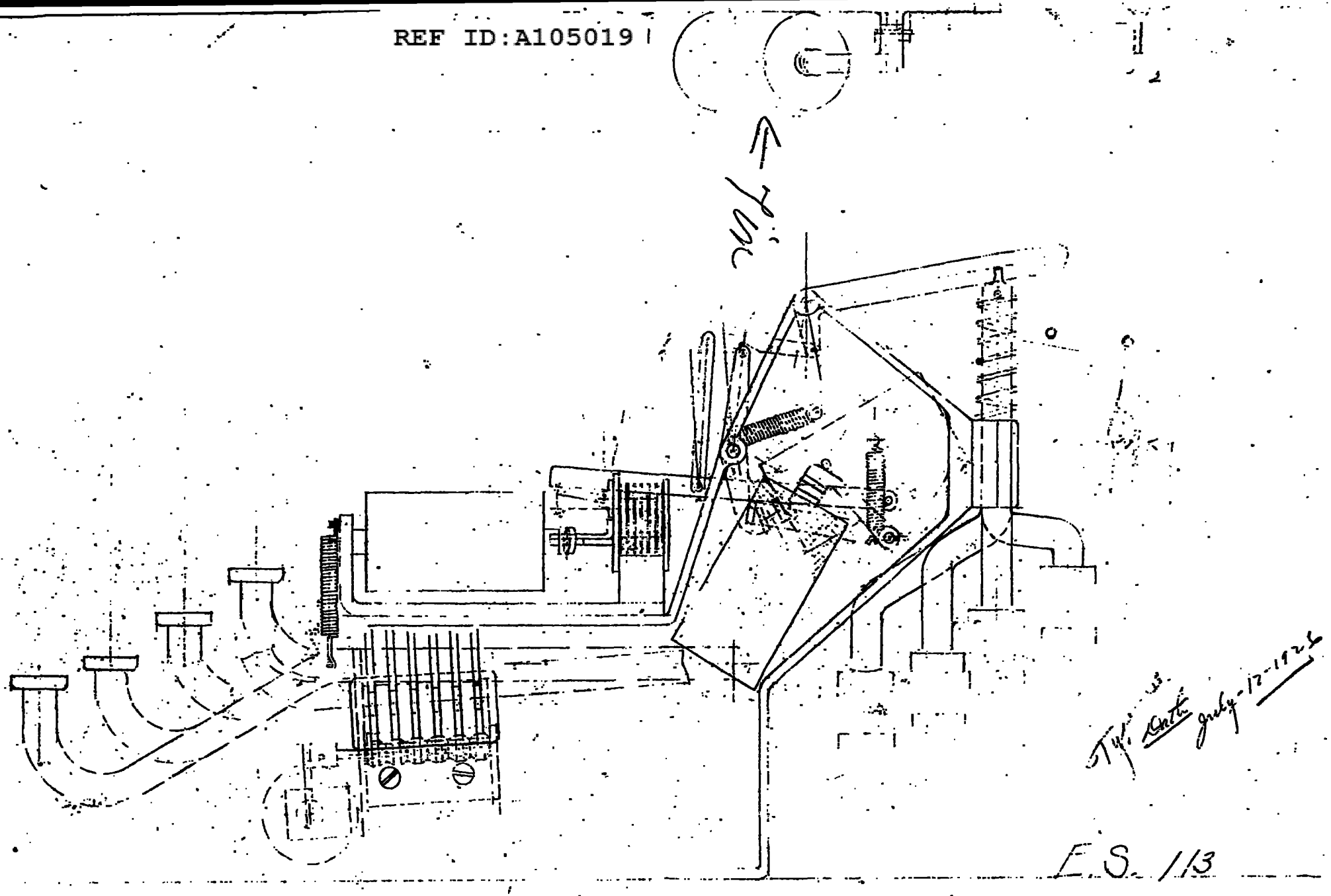

Fig.