CLASS: Cipher Machine (Electro-mechanical)
SYSTEM: Monographic Substitution, Polyalphabetic (Related Sequences)
METHOD: Circuit Rotor Maze, Through Path, Notch Motion Control

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NAME: Hebern "Super Code" Machines

DEVELOPMENT:

Invented by Edward H. Hebern. Application for basic patent filed in the United States, 20 November 1923, and assigned to International Code Machine Company of Reno, Nevada. Also patented in Belgium, Canada, Denmark, France, Great Britain, Italy, Netherlands, New Zealand, Norway, Sweden and Switzerland.

A limited number of the various models of this machine were manufactured by the Hebern Electric Code Company and its successor, named above. Of the two models known to have been sold commercially, the first appeared in the latter part of 1923, the second in 1932.

PATENTS:

U. S. 1,683,072 (E. H. Hebern, 4 September 1928, Cl. 35-4). Basic patent on a non-printing cipher machine with five circuit rotors.

U. S. 1,861,857 (E. H. Hebern, 7 June 1932, Cl. 197-4). Two machines described in this patent, one a light-board and the other a printing model, are improved versions of the above.

DESCRIPTION:

The original (1923) model of the Hebern "Super Code" is a keyboard-operated, electro-mechanical cipher machine employing five circuit rotors with odometric motion. It is somewhat smaller in size than a portable typewriter, enciphered or deciphered characters are indicated by being illuminated on a light-board, and current is supplied from a dry cell battery. The principal cryptographic components include:

(1) Five twenty-six—point, random-wired circuit rotors, similar in construction to the Hebern "Electric Code" rotor (q.v.), except that no limitation is placed on the wiring scheme.

(2) A rotor basket consisting of two endplates and four separators with ball-type spring contacts, by means of which current is conducted from rotor to rotor through the cipher unit.

(3) An encipher-decipher switch.

(4) Two control wheels, loosely mounted on the same shaft as the rotors, which through mechanical linkages cause the automatic displacement of the five rotors.

The means by which the stepping of the rotors is accomplished is shown diagrammatically in Figure 1. Each control wheel is a composite member, consisting of a ratchet wheel with twenty-six teeth and a cam disk with a single notch at one point on its periphery. Depression of any key causes the universal bar to rotate a rocker shaft (1) to which four pawls (2), (3), (4) and (5) are attached. Each time a key is depressed, Control Wheel 1 and Rotor 5 are advanced one position by pawls (2) and (3) respectively. Pawls (4) and (5) are prevented from engaging Rotors 1 and 3 by blocking arms (6) and (7). However, when the notch on Control Wheel 1 is presented at the effective position, cam follower (8) falls into it, shaft (9) rocks forward and blocking arm (10)

then allows pawl (11) to engage one of the ratchet teeth of Control Wheel 2. Pawl (11) is attached to a sleeve (12) which is free to rotate over shaft (1), and when the pawl (11) is released as described above, blocking arm (6), also attached to sleeve (12), in turn releases pawl (4). Thus, the next depression of a key causes both Control Wheel 2 and Rotor 1 to advance one step. Similarly, when the notch on Control Wheel 2 is presented at the effective position, cam follower (13), attached to sleeve (14) on shaft (9), falls into it and blocking arm (7), attached to the same sleeve, releases pawl (5) to step Rotor 3. Rotors 2 and 4 are not affected by the stepping mechanism and can only be advanced manually. The cycle of the machine produced automatically is therefore 26^3 or 17,576. In the patent (U. S. 1,683,072), two additional control wheels and associated mechanical linkages have been supplied, so that all five rotors are moved automatically and the cycle is 26^5. According to the specification, Rotor 3 is stepped every time and the others are advanced one position for each revolution of its predecessor in the cascade, arranged as follows: Rotor 1, Rotor 5, Rotor 2, Rotor 4.

An encipher-decipher switch, consisting of a movable contact board with fifty-two contacts which can assume either of two positions in relation to two sets of fifty-two fixed contacts, is supplied. Half of the movable contacts are wired to the keyboard and half to the indicating lamps; half of the fixed contacts are wired (in pairs) to the left endplate of the rotor maze and the other half are wired (in pairs) to the right endplate. The effect produced by shifting the movable contact board from one position to the other is to reverse the direction of the current paths through the rotor maze.

Variable keying elements include the set of five rotors selected from a stock of six or more supplied with the machine, the order in which they are arranged (each rotor being capable of insertion in either a normal or "upside-down" position), and the initial alignment of rotors and control wheels for a particular message encryption.

In the 1932 model of the "Super Code", the light-board of the earlier model has been replaced by an automatic printer (operated from a 110 volt D.C. power supply), and the rule of motion has been changed so that the stepping of the rotors is no longer odometric: any two of the five rotors may move continuously, a third rotor moves one step per 26 depressions on the keyboard, and the two remaining rotors move one step after 650 keys have been depressed.

The mechanism which causes the rotors to advance is shown diagrammatically in Figure 2 and consists of a ratchet cradle upon which are mounted two dog bars carrying three dogs, five rotor-stepping pawls, three ratchet pawls, two cam followers, and an arrangement (not shown) for releasing all pawls while the rotors are being set. Two identical control wheels, similar in construction to those of the first model, are located to the left of the rotor maze and are loosely mounted on an extension of the shaft which carries the rotors. Each control wheel is composed of a ratchet wheel with twenty-six teeth, each tooth designated by a letter of the alphabet, and a cam disk with a single notch extending between the teeth labeled "Y" and "Z". The front dog bar has two dogs mounted upon it which can be placed in any two of five active positions, designated by the letters A, B, C, D, E. The back dog bar carries only one dog, and also provides five active positions, designated by the letters V, W, X, Y, Z. The five rotor-stepping pawls are mounted on a shaft located beneath the two dog bars, and each pawl has two notches on it (not shown), one situated to engage a dog on the front bar, the other to engage a dog on the back bar. The dogs are individually slidable on their bars, and when a dog on either bar is in position it will normally prevent the pawl immediately beneath it from stepping the associated rotor.

The three ratchet pawls (1), (2) and (3) are mounted on the same shaft as the rotor-stepping pawls. Of these, ratchet pawl (1) moves Control Wheel 1

forward one step each time a key is depressed; that is its only function. Ratchet pawl (2) carries a projection on its left side to which a cam follower (4) is attached. Except when this cam follower drops into the notch on Control Wheel 1, ratchet pawl (2) is inoperative. However, when this happens (once per 26 encipherments), pawl (2) performs two functions: it engages Control Wheel 2 to move it forward one position and, through a mechanical linkage with the back dog bar, it neutralizes the blocking action of the back dog so that the rotor-stepping pawl temporarily associated with this dog is allowed to engage its rotor and advance it one step. Ratchet pawl (3) has a cam follower (5) attached to it and riding on the cam surface of Control Wheel 2. When the notch on this wheel is presented at the effective position, cam follower (5) drops into it, allows ratchet pawl (3) to step Control Wheel 2 and neutralizes the blocking action of the front dogs, thus permitting the rotor-stepping pawls temporarily associated with these dogs to step the proper two rotors. The two rotor-stepping pawls which are not associated with any of the three dogs will, of course, step their rotors every time. The type of rotor movement produced by this machine is a variety of so-called "quasimetric" motion in which (with no overlapping dogs) there are two fast, one medium and two slow rotors, the particular positional arrangement of the "senior" and "junior" rotors in the cascade depending on the setting of the three dogs on the front and back dog bars.

In U. S. Patent 1,861,857 a light-board and a tape-printing model of another machine is described which, though similar to the 1932 "Super Code", provides greater flexibility of motion control and differs in one important aspect: the control wheels have been eliminated and the notches which govern the motion have been placed on the peripheries of the rotors themselves. A stepping pawl and a cam follower are provided for each rotor and are loosely mounted on a shaft underneath a set of four dog bars. Each of these bars has ten positions in which dogs, in the form of removable pins, may be placed. Usually two pins are placed in each bar, one associated with a given rotor-stepping pawl and the other with the cam follower of a different rotor. In Figure 3 the essential features of this assembly are shown. The blocking action of the two pins on a dog bar causes the rotor-stepping pawl to remain inoperative except when the cam follower drops into the notch on its rotor, in which case the pawl is released (the dog bar being rotated slightly) and is thereby allowed to step the rotor temporarily associated with it. At least one rotor always steps after each encipherment, but by using more than two pins on any or several of the dog bars, a variety of different effects can be achieved (e.g., one rotor may be moved by the notches on two or more other rotors, the notch on one rotor may step two or more different rotors, etc.).

In the printing model of this machine as described in the patent, tape copy of both plain and cipher texts is produced. Two sets of type bars, activated by electromagnets, are used and the plain and cipher letters are simultaneously printed, one above the other, on a single paper tape which is subsequently split into its plain and cipher components by means of a set of shearing rollers. Cipher text is automatically spaced in five-letter groups by conventional mechanical means. Plain text is spaced according to word lengths by connecting the space bar to an infrequent key lever (e.g., "Z"); in decipherment, the "Z" type bar is rendered inoperative by means of a blocking arm acting upon the armature of its electromagnet, and therefore a space will appear in the deciphered text at all points where the letter "Z" would ordinarily occur.

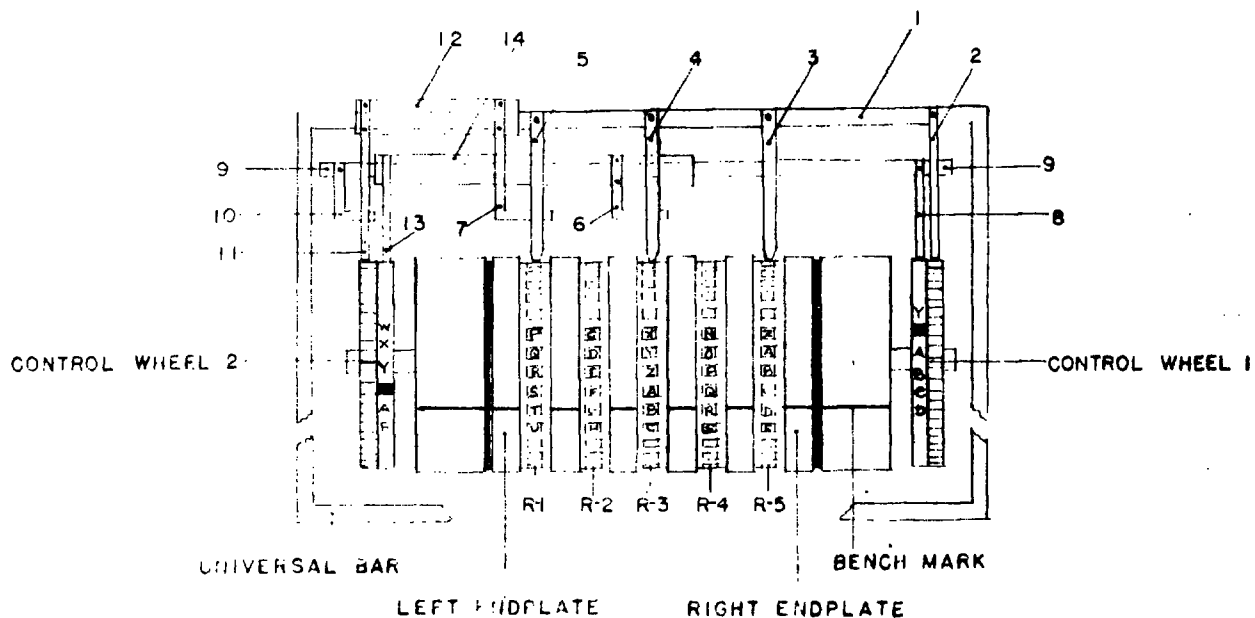(A Hebern "Super Code" machine, 1923 Model is available for inspection in the ASA Museum.)
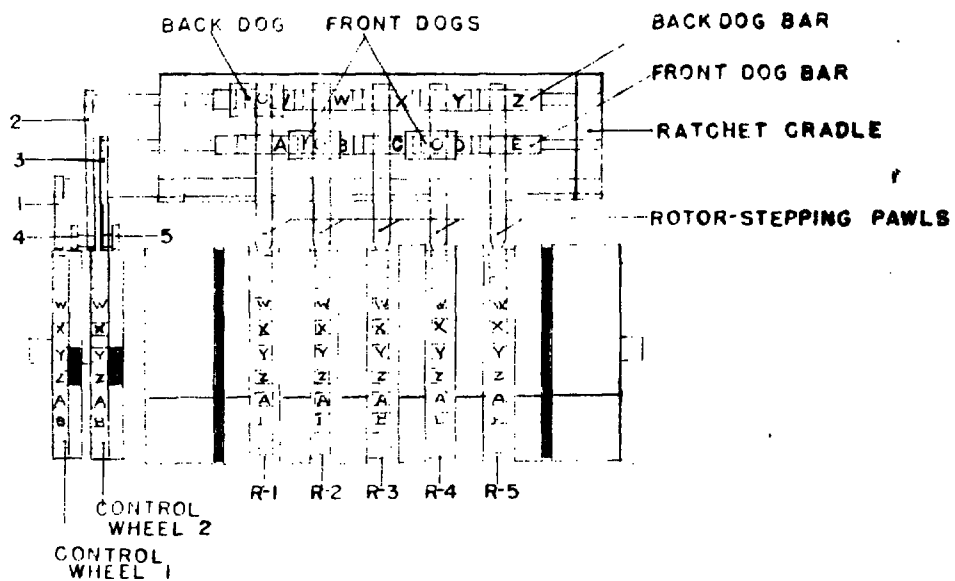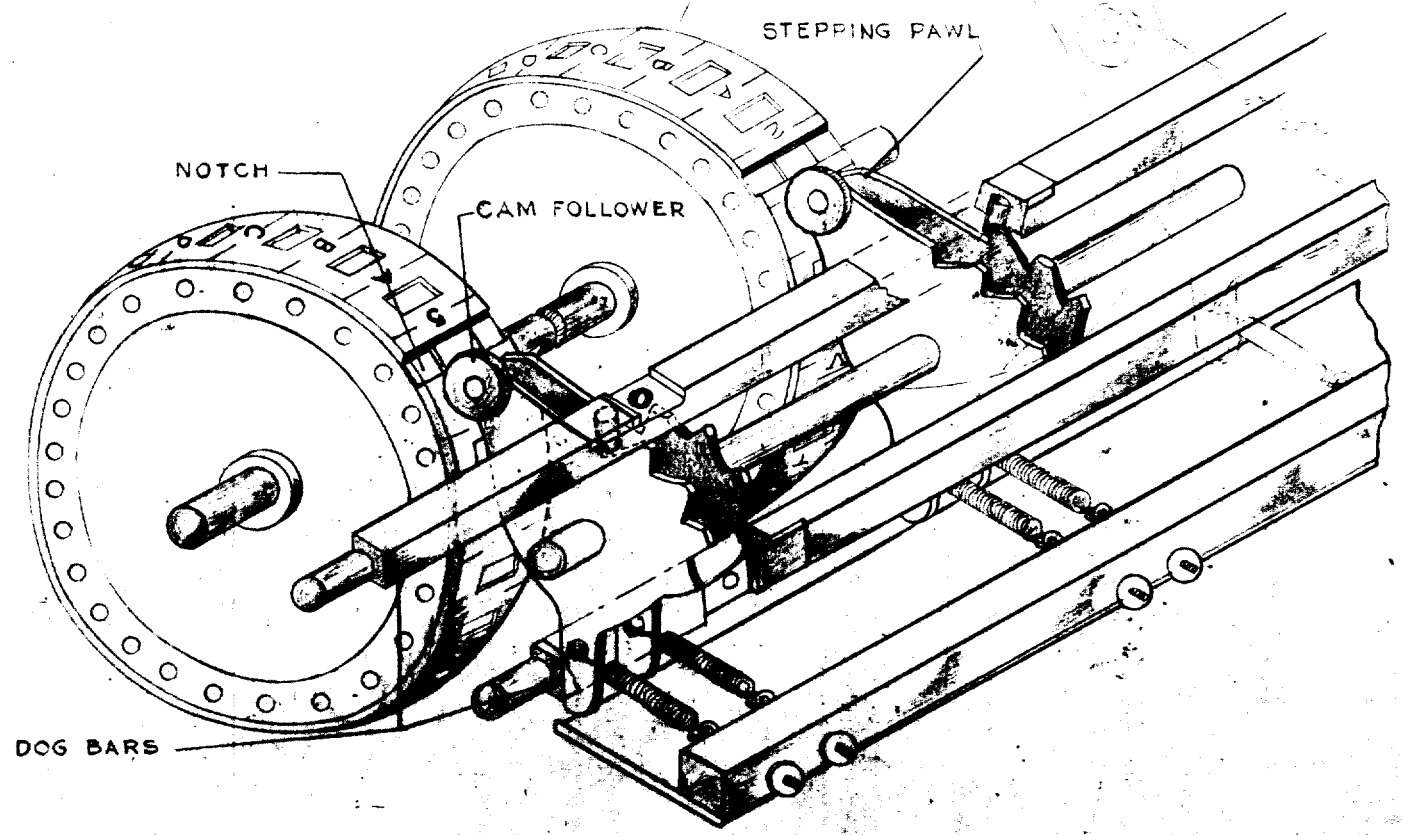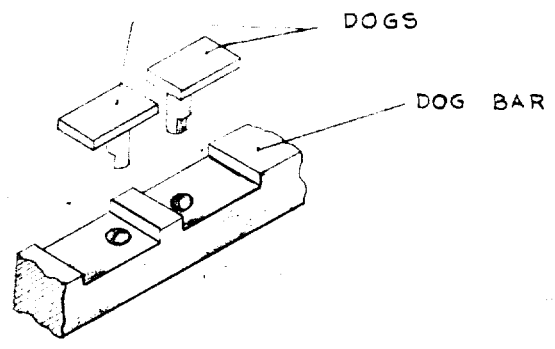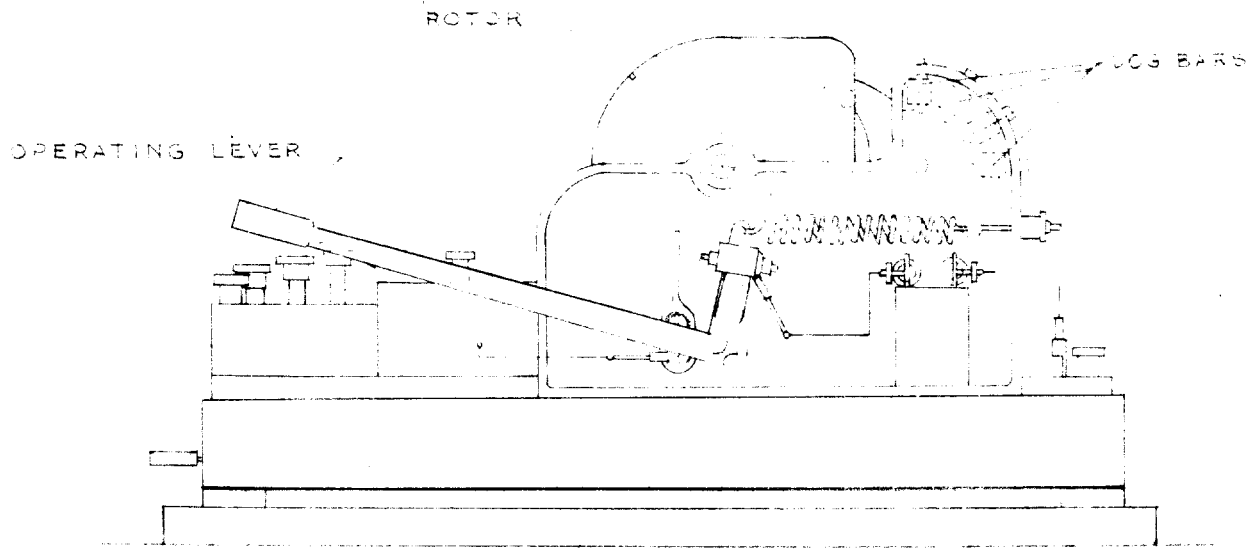
FIGURE 1

FIGURE 2

HEBERN "SUPER CODE" MACHINES

ROTOR

OPERATING LEVER

DOGS BARS

DOGS

DOG BAR

STEPPING PAWL

NOTCH

CAM FOLLOWER

DOG BARS

FIGURE 3