

3rd Memo. Ind.

W.P. & T.Div., OCSigO, November 25, 1930 - To Research & Development Division.

1. As suggested in the 2nd Memo. Ind., there is attached hereto a statement of requirements in the form of a general performance specification applicable to the cipher machine under consideration.

2. Mr. Friedman of this Division will be available at any time to discuss further details that may arise in connection with this project.

R. B. Moran,
Captain, Signal Corps.

Attached-
Specification.

WAR DEPARTMENT

SIGNAL CORPS LABORATORIES

OFFICE OF THE OFFICER IN CHARGE

FORT MONMOUTH

IN REPLY REFER TO

OCEANPORT, NEW JERSEY
November 26, 1930

Mr. William Friedman,
Office of the Chief Signal Officer,
War Department,
Washington, D.C.

My dear Friedman:

There is attached a general specification and operating requirements of the cipher machine. It may very well be that you may want to add to this or eliminate certain parts; do as you wish in this respect.

It is recommended, however, the matter be turned over to the R. & D. Division at the first opportunity inasmuch as the funds seem to be available. It is believed that there is sufficient information attached herewith to enable Ersfeld to make an intelligent bid. Upon his starting work, there are many little points which I would like to talk to him about without consuming the time necessary to making drawing layouts, etc. You will note that the overall dimensions given are somewhat in excess of that of the standard portable typewriter. This is due to the necessity of embodying a tape transmitter which in itself has an overall dimension of $6\frac{1}{4}$ " x $4\frac{1}{2}$ " x 4", and weighs approximately 6 pounds.

Very truly yours,



GEORGE A. GRAHAM
Electrical Engineer

1 incl.

GAG:F

Nov. 1930

SPECIFICATION FOR FIELD CIPHER MACHINE

1. This specification describes a portable cipher machine to be used by the Army for enciphering and deciphering messages in the field or at permanent locations. It is desired that the overall dimensions be within 6" x 10" x 12" and that the approximate weight not exceed 22 lbs. It is intended that the cipher machine be used with 4 volt battery. The battery will be of the BB-29 storage type and is not to be furnished as a part of the machine.

2. It is to be assumed that messages enciphered with this machine will be deciphered subsequently with a similar machine using the same setting of certain operational features. The machine shall consist of a proper frame; a three-row keyboard constituted of only the 26 letters of the alphabet and without any other keys and associated bars such as the space bar; etc.; a bank of 26 small lamps, positioned properly on an inclined plane with the 26 letters of the alphabet designating each lamp; a rotatable cipher wheel the orientation of which is determined by the continuity of certain electrical circuits set up by the interaction of a tape transmitter in setting up certain sequences in conjunction with five switches operated permutatively as a set by pins on the periphery of the cipher wheel, a motor or other means being provided for preserving tension on the spring which rotates the cipher wheel. Proper magnets shall be provided for releasing the cipher wheel and for stepping forward the tape in the tape transmitter. A relay shall be provided which functions to impulse the circuit at proper time and release same. This assembly shall function so that in enciphering a message the plain-text character will be struck manually on the keyboard. This particular key will close a contact and a circuit will be closed depending upon the position at that instant of the cipher wheel and the set of contacts established at the tape transmitter. A particular lamp shall be illuminated, thereby designating the cryptographic letter resulting from that combination. Upon deciphering, the reciprocal action shall ensue, i.e., upon depressing the cryptographic character key on the keyboard, and given that the cipher wheel and tape transmitter are in the same setting, as they were at the time of encipherment of that character, the proper plain-text character will result.

3. The keyboard shall be provided with a standard three-row arrangement of keys using only the 26 letters of the alphabet. Each key bar shall be provided with an individual insulated contact which is properly positioned over a fixed contact mounted integral to and insulated from the machine frame. The key-bar contacts shall be wired in common to one side of the battery. The fixed or stationary contacts shall be wired to small, spring plungers which make contact with flush studs on the cipher wheel to be described later. It will therefore be seen that all 26 contacts are commoned to battery on one side, the other 26 contacts going to the 26 plungers which act on the cipher wheel.

4. The cipher wheel shall be made of bakelite or suitable insulating material of cylindrical form and carried upon preferably a vertical shaft. This shaft shall at all times be provided with spring tension tending to rotate the cipher wheel about the shaft. A small motor may be used to preserve this tension on the spring. Auxiliary methods of preserving this tension will be considered. The cipher wheel shall be provided on its periphery with 26 teeth equally spaced. These teeth shall work into a lock pawl which shall determine the position at which the cipher wheel shall stop. Properly in line with these teeth, and preferably above, there shall be five pins set into the periphery of the wheel in line above each tooth. This is to be construed as 130 pins in all consisting of 26 rows approximately 13.85° apart with 5 pins per row. The action of these pins will be described later. The cipher wheel will have two heads or faces. Each of these faces, top and bottom, shall be provided with 26 metallic contact studs for each of the stop positions determined by the teeth about the periphery. These studs shall make contact with the same number of plungers mounted integral with the machine and positioned above and below the cipher wheel. The studs of the cipher wheel shall be connected from one face to the opposite face by means of flexible conductors passing through the interior of the wheel. This wiring shall be such that a reciprocal relationship is preserved between connections to various letters.

- 3 -

5. The lamp bank shall consist of 26 lamp sockets and lamps mounted on an insulated panel at a convenient angle for observation to the horizontal plane of the machine. These lamps shall be arranged in 3 rows and be designated by the 26 letters of the alphabet. A preferred method of designation is to have each lamp set behind a ground glass disc upon which the letter is painted with a suitable black paint, so that when the lamp is illuminated the letter shows clearly upon the ground glass surface.

6. A tape transmitter of a type commonly used in printing telegraph practice shall be furnished to the contractor. This tape transmitter is designed for use with a tape of the five-unit Baudot code. The holes in the tape determine which of a set of 5 contacts shall be made at any instant. These contacts shall be wired to interact with the contacts which are operated by the pins on the periphery of the cipher wheel. The wiring in this respect is shown in Figure 1. A tape-stepping magnet is provided for stepping forward the tape once for every operation of the keyboard. It will be necessary to rewind this magnet for 4-volt operation and to wire the magnet so that it operates by universal bar action upon releasing any key of the keyboard. This may be done as a relay function.

7. The circuit wiring shall be as shown in attached Figure 1. Alternate methods performing the same function will be considered. It will be noted that operation of a given key such as "W" will set up a circuit from battery 11 through the key contacts, through the cipher wheel, lower and upper contacts, through lamp designated "Q", and return to battery. The lamp will be illuminated and the letter "Q" designated thereby for this operation of the "W" key with the cipher wheel in that particular position. The action of depressing the "Q" key shall have a reciprocal relationship and the lamp designated "W" shall be illuminated. It is desired that this relationship be preserved for the 26 letters of the alphabet as operated by the keyboard for every one of the 26 positions in which the cipher wheel may be set. This is simply a matter of proper wiring throughout. The circuit arrangements for stopping the cipher

wheel at any given position are also shown. Dependent upon the continuity through the various contacts between wire 30 and wire 31 determines the positions of stoppage of the cipher wheel by means of the armature or pawl of the wheel stepping magnet 25. The one series of contacts designated 26 act in accordance with the particular permutation of the holes in the tape in the tape transmitter at a given instant. The other set of contacts designated 22 act in accordance with the particular permutation of pins on the periphery of the cipher wheel that presents itself at a particular moment to the contact levers operated by them. The pins on the cipher wheel must individually be capable of being either brought into operative position or left in a neutral position, thus allowing of 26 different groupings or permutations of operative and neutral pins around the periphery of the cipher wheel. The purpose of having the pins capable of being set into an operative or neutral position is so that various permutations can be set up and changed at will. It is desired that the wheel be released and stopped dependent upon the joint action of the set of tape-transmitter contacts and the set of contacts controlled by the pins on the cipher wheel, according to the rule that so long as the permutation of contacts set up at the tape transmitter is different from that set up at 22 by the pins on the cipher wheel, the latter continues stepping, and stops only when those two sets of contacts coincide. A tape-stepping, 27, magnet is shown, operated by relay 28. A relay shall be provided such as that shown at 28, which performs whatever requirements are necessary such as tape-stepping and control for cipher wheel. The action of this relay may be made to interact mechanically with a universal bar on the keyboard.

8. Further details of the machine as described above may be worked out in agreement between the contractor and a representative of the Signal Corps. The inspection will consist in testing the machine for successful operation in enciphering and deciphering messages with a cipher tape, a minimum speed of operation of 60 characters per minute being required for either encipherment or decipherment. Proper cipher tapes will be furnished the contractor. It will

- 5 -

be necessary in the development that certain experimental work be done. The bidder should take these features into consideration as a finished product is desired. It is believed that sufficient details have been given to provide the basis of an intelligent bid. Further details will be provided as the work of assembly progresses.

SPECIFICATION FOR FIELD CIPHER MACHINE

1. This specification describes a portable cipher machine to be used by the Army for enciphering and deciphering messages in the field or at permanent locations. It is desired that the overall dimensions be within 6" x 10" x 12" and that the approximate weight not exceed 22 lbs. It is intended that the cipher machine be used with a 4 volt battery. The battery will be of the HB-29 storage type and is not to be furnished as a part of the machine.

2. It is to be assumed that messages enciphered with this machine will be deciphered subsequently with a similar machine using the same setting of certain operational features. The machine shall consist of a proper frame; a three-row keyboard constituted of only the 26 letters of the alphabet and without any other keys and associated bars such as the space bar; etc.; a bank of 26 small lamps, positioned properly on an inclined plane with the 26 letters of the alphabet designating each lamp; a rotatable cipher wheel the orientation of which is determined by the continuity of certain electrical circuits set up by the interaction of a tape transmitter in setting up certain sequences in conjunction with five switches operated permutatively as a set by pins on the periphery of the cipher wheel, a motor or other means being provided for preserving tension on the spring which rotates the cipher wheel. Proper magnets shall be provided for releasing the cipher wheel and for stepping forward the tape in the tape transmitter. A relay shall be provided which functions to impulse the circuit at proper time and release same. This assembly shall function so that in enciphering a message the plain-text character will be struck manually on the keyboard. This particular key will close a contact and a circuit will be closed depending upon the position at that instant of the cipher wheel and the set of contacts established at the tape transmitter. A particular lamp shall be illuminated, thereby designating the cryptographic letter resulting from that combination. Upon deciphering, the reciprocal action shall ensue, i.e., upon depressing the cryptographic character key on the keyboard, and given that the cipher wheel and tape transmitter are in the same setting, as they were at the time of encipherment of that character, the proper plain-text character will result.

3. The keyboard shall be provided with a standard three-row arrangement of keys using only the 26 letters of the alphabet. Each key bar shall be provided with an individual insulated contact which is properly positioned over a fixed contact mounted integral to and insulated from the machine frame. The key-bar contacts shall be wired in common to one side of the battery. The fixed or stationery contacts shall be wired to small, spring plungers which make contact with flush studs on the cipher wheel to be described later. It will therefore be seen that all 26 contacts are commone~~d~~^d to battery on one side, the other 26 contacts going to the 26 plungers which act on the cipher wheel.

4. The cipher wheel shall be made of bakelite or suitable insulating material of cylindrical form and carried upon preferably a vertical shaft. This shaft shall at all times be provided with spring tension tending to rotate the cipher wheel about the shaft. A small motor may be used to preserve this tension on the spring. Auxiliary methods of preserving this tension will be considered. The cipher wheel shall be provided on its periphery with 26 teeth equally spaced. These teeth shall work into a lock pawl which shall determine the position at which the cipher wheel shall stop. Properly in line with these teeth, and preferably above, there shall be five pins set into the periphery of the wheel in line above each tooth. This is to be construed as 130 pins in all consisting of 26 rows approximately 13.85° apart with 5 pins per row. The action of these pins will be described later. The cipher wheel will have two heads or faces. Each of these faces, top and bottom, shall be provided with 26 metallic contact studs for each of the stop positions determined by the teeth about the periphery. These studs shall make contact with the same number of plungers mounted integral with the machine and positioned above and below the cipher wheel. The studs of the cipher wheel shall be connected from one face to the opposite face by means of flexible conductors passing through the interior of the wheel. This wiring shall be such that a reciprocal relationship is preserved between connections to various letters.

- 3 -

5. The lamp bank shall consist of 26 lamp sockets and lamps mounted on an insulated panel at a convenient angle for observation to the horizontal plane of the machine. These lamps shall be arranged in 3 rows and be designated by the 26 letters of the alphabet. A preferred method of designation is to have each lamp set behind a ground glass disc upon which the letter is painted with a suitable black paint, so that when the lamp is illuminated the letter shows clearly upon the ground glass surface.

6. A tape transmitter of a type commonly used in printing telegraph practice shall be furnished to the contractor. This tape transmitter is designed for use with a tape of the five-unit Baudet code. The holes in the tape determine which of a set of 5 contacts shall be made at any instant. These contacts shall be wired to interact with the contacts which are operated by the pins on the periphery of the cipher wheel. The wiring in this respect is shown in Figure 1. A tape-stepping magnet is provided for stepping forward the tape once for every operation of the keyboard. It will be necessary to rewind this magnet for 4-volt operation and to wire the magnet so that it operates by universal bar action upon releasing any key of the keyboard. This may be done as a relay function.

7. The circuit wiring shall be as shown in attached Figure 1. Alternate methods performing the same function will be considered. It will be noted that operation of a given key such as "W" will set up a circuit from battery 11 through the key contacts, through the cipher wheel, lower and upper contacts, through lamp designated "Q", and return to battery. The lamp will be illuminated and the letter "Q" designated thereby for this operation of the "W" key with the cipher wheel in that particular position. The action of depressing the "Q" key shall have a reciprocal relationship and the lamp designated "W" shall be illuminated. It is desired that this relationship be preserved for the 26 letters of the alphabet as operated by the keyboard for every one of the 26 positions in which the cipher wheel may be set. This is simply a matter of proper wiring throughout. The circuit arrangements for stopping the cipher

- 4 -

wheel at any given position are also shown. Dependent upon the continuity through the various contacts between wire 30 and wire 31 determines the positions of stoppage of the cipher wheel by means of the armature or pawl of the wheel stepping magnet 25. The one series of contacts designated 26 act in accordance with the particular permutation of the holes in the tape in the tape transmitter at a given instant. The other set of contacts designated 22 act in accordance with the particular permutation of pins on the periphery of the cipher wheel that presents itself at a particular moment to the contact levers operated by them. The pins on the cipher wheel must individually be capable of being either brought into operative position or left in a neutral position, thus allowing of 26 different groupings or permutations of operative and neutral pins around the periphery of the cipher wheel. The purpose of having the pins capable of being set into an operative or neutral position is so that various permutations can be set up and changed at will. It is desired that the wheel be released and stepped dependent upon the joint action of the set of tape-transmitter contacts and the set of contacts controlled by the pins on the cipher wheel, according to the rule that so long as the permutation of contacts set up at the tape transmitter is different from that set up at 22 by the pins on the cipher wheel, the latter continues stepping, and stops only when these two sets of contacts coincide. A tape-stepping, 27, magnet is shown, operated by relay 28. A relay shall be provided such as that shown at 28, which performs whatever requirements are necessary such as tape-stepping and control for cipher wheel. The action of this relay may be made to interact mechanically with a universal bar on the keyboard.

8. Further details of the machine as described above may be worked out in agreement between the contractor and a representative of the Signal Corps. The inspection will consist in testing the machine for successful operation in enciphering and deciphering messages with a cipher tape, a minimum speed of operation of 60 characters per minute being required for either encipherment or decipherment. Proper cipher tapes will be furnished the contractor. It will

- 5 -

be necessary in the development that certain experimental work be done. The bidder should take these features into consideration as a finished product is desired. It is believed that sufficient details have been given to provide the basis of an intelligent bid. Further details will be provided as the work of assembly progresses.