Aug. 5, 1947. L. ROSEN 2,425,006

CRYPTOGRAPHIC MACHINE

Filed Jan. 12, 1944 2 Sheets-Sheet 1

FIG. 3.

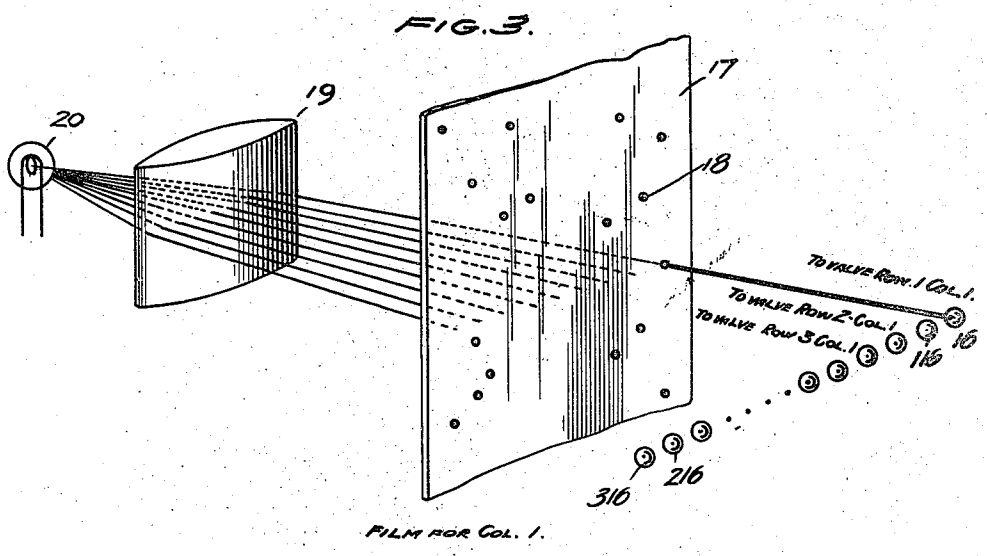
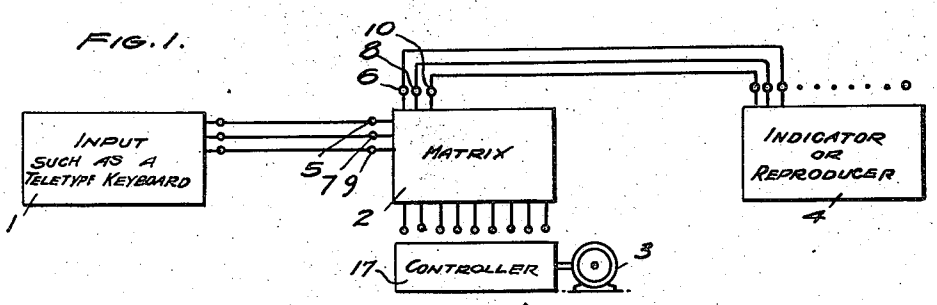


FIG. 1.



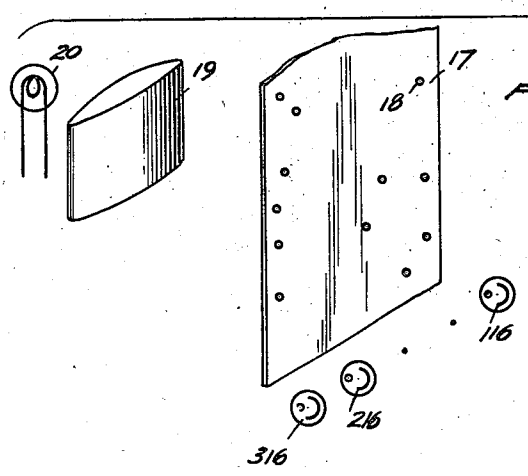
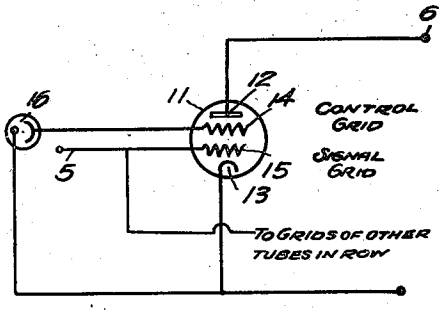


FIG. 4.



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CRYPTOGRAPHIC MACHINE

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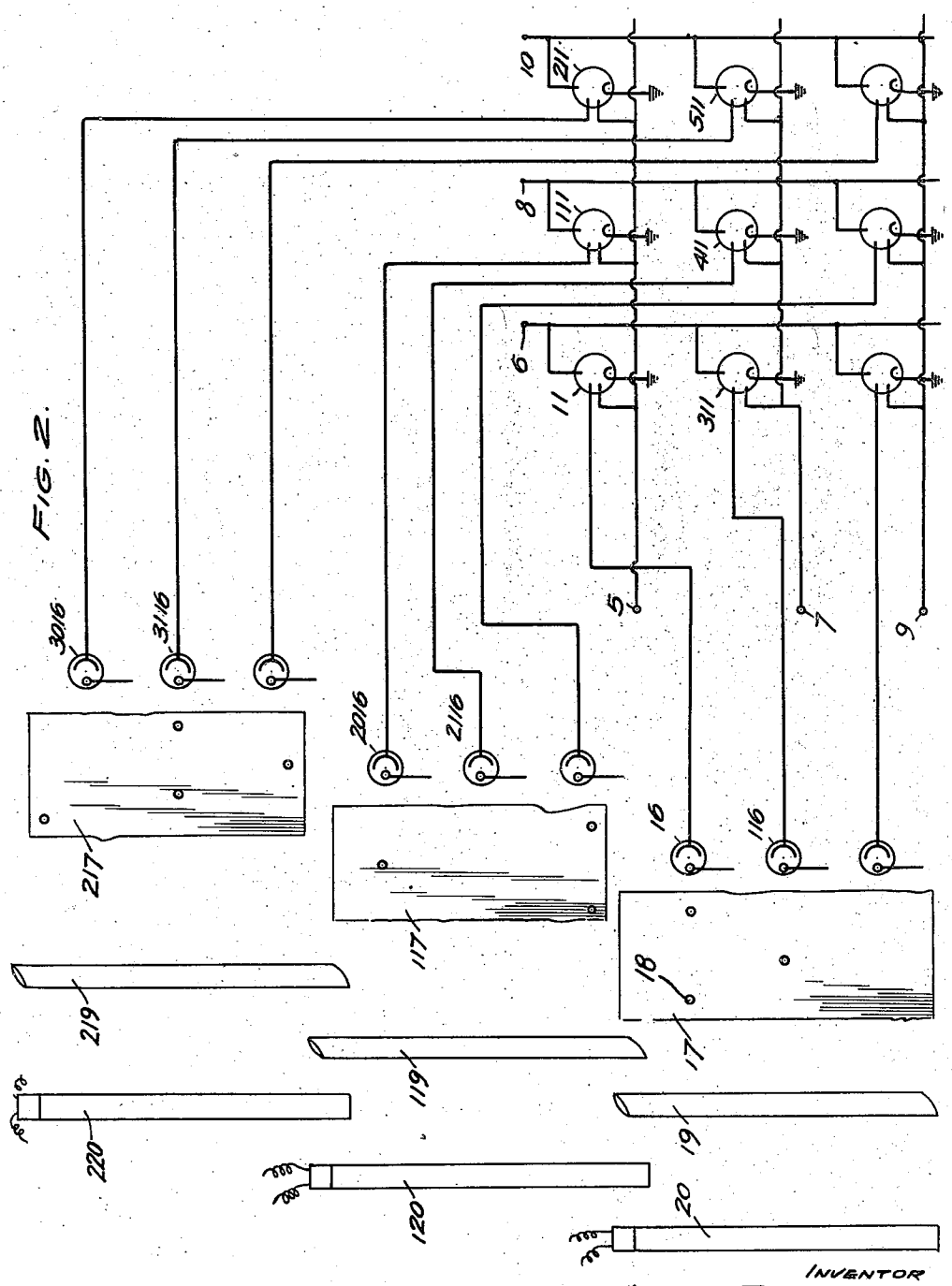

FIG. 2.

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UNITED STATES PATENT OFFICE

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CRYPTOGRAPHIC MACHINE

Leo Rosen, United States Army,
Arlington County, Va.

Application January 12, 1944, Serial No. 517,991

5 Claims. (Cl. 35—4)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

Modern cryptographing or ciphering machines employ electric circuit connections or a matrix having a plurality of inlets or electric input terminals and a plurality of outlets or electric output terminals. These terminals may conveniently be arranged along the sides of a square consisting of rows in one direction and columns in the other direction. These rows and columns are formed by circuit-makers-and-breakers interposed between each inlet and each outlet. Each circuit-maker-and-breaker is separately controlled.

In some embodiments, the inlets may be connected to a keyboard similar to that of a typewriter or teletype, while the outlets are connected to an indicator, such as a bank of lights, or to a reproducer, such as a bank of electromagnetically operated typewriter keys or telegraph keys.

In another embodiment, the inlets and outlets may form part of a plurality of telephone circuits.

In any case, the purpose of the electric connections or matrix is to provide for scrambling or mixing the connections between each inlet and each outlet.

Therefore, it is an object of this invention to provide a cryptographic matrix having a plurality of inlets and a plurality of outlets so arranged that any desired inlet can be connected to any desired outlet at will and at high speed.

It is the further object of this invention to provide means for effecting a large number of such different connections simultaneously.

Yet another object of this invention is to provide means for rapidly producing a large number of the possible matrix connections in a predetermined order and in rapid controlled succession.

For a further exposition of my invention, reference may be had to the annexed drawings and specifications.

In the drawings,

Fig. 1 is a block diagram showing the invention.

Fig. 2 is a diagram showing the invention in greater detail.

Fig. 3 is a diagram showing in detail the control means.

Fig. 4 is a diagram showing one circuit from an input terminal to an output terminal and a thermionic valve serving as the means for opening and closing the circuit.

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In that embodiment of my invention selected from among others for description in the specification and illustration in the drawings, there is shown, in Fig. 1, as a block diagram, an input 1, such as the keyboard of a teletypewriter or the like. Each of the keys forming this keyboard controls or influences a separate circuit which is connected to an inlet or input terminal 5, 7, 9, etc., of a cryptographic matrix 2 having a plurality of outlets or output terminals 6, 8, 10, etc. Ordinarily there will be 26 such inlets and 26 such outlets to correspond to the letters of the alphabet. Between each of these inlets and each of these outlets there is provided an electric switch or circuit-maker-and-breaker. These may be arranged in horizontal rows and vertical columns. Each circuit-maker-and-breaker may consist of any quick acting electric switch, but in the preferred embodiment thermionic tubes are employed (see Figs. 2 and 4). Each of these switches is controlled or actuated into its circuit-making and circuit-breaking positions by a controller 17, hereinafter more fully described, which in turn may be revolved or otherwise cyclically operated, as by motor 3. Each outlet 6, 8, 10, etc., is connected to an indicator such as one of a bank of lights, or to a reproducer such as one of a bank of telegraph or typewriter keys. This indicator or reproducer is generally indicated by the reference character 4.

Referring to Fig. 2 there are shown nine such tubes 11, 111, 211, etc., each of which may be either a triode, tetrode, or a pentode. It is to be understood that Figs. 2 and 4 are illustrative only, and that the supply circuits, the means for heating the cathodes, the return circuits, and like well known electronic circuit elements have been omitted.

In Fig. 2, one corner of a cryptographic matrix is illustrated. Vacuum tubes 11, 111, 211, 311, 411, 511, etc., are connected between inlets 5, 7, 9 and outlets 6, 8 and 10. Connected to the control grid of each of these vacuum tubes 11, 111, etc., is a photoelectric cell 16, 116, etc., 2016, 2116, etc., 3016, 3116, etc. These photoelectric cells are in turn governed by controllers 17, 117, 217, etc., in the form of tapes or films which may be cyclically or repeatedly operated by motors such as that shown in Fig. 1 at 3. Light from sources 20, 120, 220, etc., is focused by lenses 19, 119, 219, etc., on the photocells, but films or tapes 17, 117, 217, etc., which are partially transparent and partially opaque, as will be hereinafter more fully

described, actually govern the activation of the cells.

In Fig. 4 a tetrode is illustrated having an anode 12, connected into circuit with outlet 6, and a cathode 13. There is also provided a control grid 14, and a signal grid 15 connected into circuit with inlet 5. Connected to control grid 14 is a photoelectric cell 16, forming one of a row or bank of such photoelectric cells corresponding in number and alignment to the inlets or outlets in the row or column it is desired to control. These photoelectric cells are illustrated in Fig. 3 as 16, 116, . . . 216, and 316. Adjacent these photoelectric cells there is provided a light-controlling element or screen shown in the form of a film 17 of material having light-controlling characteristics of one quality, i. e. either transparent or opaque. On film 17 are provided a plurality of spots or portions 18 of the opposite light-controlling quality. Lens 19 focuses the rays from a source of light 20 so that the rays fall on the photoelectric cells 16, 116, etc., under the control of the portions 18 of the film 17. As seen in Fig. 2 there are provided as many films 17, 117, 217, etc., (in this instance, three), as there are rows or columns of inlets and outlets. All that is necessary is that there be provided means for individually controlling each switch or thermionic tube separately and at any desired time.

It will be apparent that there is provided between each inlet and each outlet, a switch, and since a separate control is provided for each of these switches, connections can be closed between each inlet and any or all of the outlets. Moreover, these connections can be closed individually or simultaneously. Also, films 17, 117, etc., can be cyclically operated so as to vary the connections between the inlets and the outlets in a predetermined order and in rapid controlled succession. Tracing more specifically from Fig. 4, the operation of controlling the circuit between inlet 5 and outlet 6 it will be seen that the movement of film 17 causes each successive spot 18 occurring lengthwise of film 17 to vary the quantity of light which falls upon photoelectric cell 16. Photoelectric cell 16 in turn applies a corresponding voltage to control grid 14. In vacuum tube 11, a certain voltage thus applied to the control grid 14, causes tube 11 to act as an amplifier insofar as the action of signal grid 15 with regard to anode 12 is concerned. Another value of voltage applied to the control grid 14 causes tube 11 to "cut-off" as far as the signal grid 15 is concerned, so that all signals applied to the signal grid 15 while the tube is below "cut-off" voltage will not affect the anode circuit of tube 11. If a triode is employed as the controlling switch, the grids 15 and 14 are physically combined into one. The signal applied to terminal 5 acts as the signal voltage, while the varying voltage of the photoelectric cell acts as the bias voltage. If a pentode is employed, the suppressor grid is preferably tied to the cathode, and the tube operated as above described. It will thus be seen that the number of spots 18 which simultaneously affect the aligned photoelectric cells 16, 116, etc., determines the number of circuits which are simultaneously closed between the inlets 5, 7, 9, etc., and the outlets 6, 8, 10, etc.

Assuming, then, that the power supply is connected and is turned on, and therefore that lamps 20, 120, 220, etc., are lighted, and that at least one opening 18 in a film 17 is aligned with a photocell, as 16, the actual operation of my invention, according to the preferred method, is as follows: Upon pressing the A key of the input keyboard 1, a voltage of predetermined magnitude is impressed on the signal grids of some row of tubes in the switching matrix, as row 11, 111, 211, Figure 2. Only one of these tubes, however, will ignite, that being tube 11, the control grid of which has already been biased through the activation of photocell 16. The output of tube 11 is transmitted through outlet 6 to an indicator in the nature of a teletypewriter, and it may be that the resulting signal will cause the letter N to be printed.

Upon release of key A on keyboard 1, at least one of the films 17 is automatically or otherwise moved a measured amount, to bring one or more of the openings 18 in line with a photocell, and the operation may be repeated. Should key A be again struck it may be that tetrode 111 will ignite, and the signal will be carried through outlet 8 to the reproducing mechanism 4 to cause the letter R to be printed.

The specific nature of the above description should not be construed as limiting the invention, for the true scope of which reference should be had to the appended claims.

I claim:

1. In a ciphering machine having a plurality of inputs and outputs; a plurality of circuit-makers-and-breakers each adapted to control the connections between one of said inputs and one of said outputs, there being a sufficient number of said circuit-makers-and-breakers to connect each of said inputs to each of said outputs, a plurality of photoelectric cells each connected to one of said circuit-makers-and-breakers so as to control the flow of electricity therethrough when said photoelectric cell is activated, and cyclically operating means controlling the activation of said photoelectric cells.

2. In a ciphering machine having a plurality of inputs and outputs; a plurality of circuit-makers-and-breakers each adapted to control the connections between one of said inputs and one of said outputs, there being a sufficient number of said circuit-makers-and-breakers to connect each of said inputs to each of said outputs, a plurality of photoelectric cells each connected to one of said circuit-makers-and-breakers so as to control the flow of electricity therethrough when said photoelectric cells are activated, and at least one movably mounted screen controlling the amount of light falling on each of said photoelectric cells thereby controlling the activation of it.

3. In a ciphering machine having a plurality of inputs and outputs; a plurality of circuit-makers-and-breakers each adapted to control the connections between one of said inputs and one of said outputs, there being a sufficient number of said circuit-makers-and-breakers to connect each of said inputs to each of said outputs, a plurality of photoelectric cells each connected to one of said circuit-makers-and-breakers so as to control the flow of electricity therethrough when said photoelectric cells are activated, at least one movably mounted screen controlling the amount of light falling on each of said photoelectric cells thereby controlling the activation of it, and a source of light whose rays are focused on said photoelectric cells and are controlled by said screen.

4. In a ciphering machine having a plurality of inputs and outputs; a plurality of thermionic tubes, each having at least a cathode, an anode, and a grid therein, a grid of each said tubes being

connected into circuit with one of said inputs so that a signal voltage may be applied thereby across the grid circuit of each of said tubes, the anode circuit of each of said tubes being connected into circuit with one of said outlets so that each of said tubes is adapted to provide an electric connection between one of said inputs and one of said outputs, there being a sufficient number of tubes to provide a connection between each of said inputs and each of said outputs, a plurality of photoelectric cells each connected to a grid of one of said tubes so that each photoelectric cell, when activated, applies a bias voltage to one of said tubes and causes said tube to cut off connection between said input and said output, and cyclically operating means controlling the activation of said photoelectric cells.

5. A ciphering machine according to claim 4

in which each of said thermionic tubes has a signal grid and a control grid, a signal voltage being applied to said signal grid, and the voltage of one of said photoelectric cells being applied to said control grid.

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