

May 29, 1945.

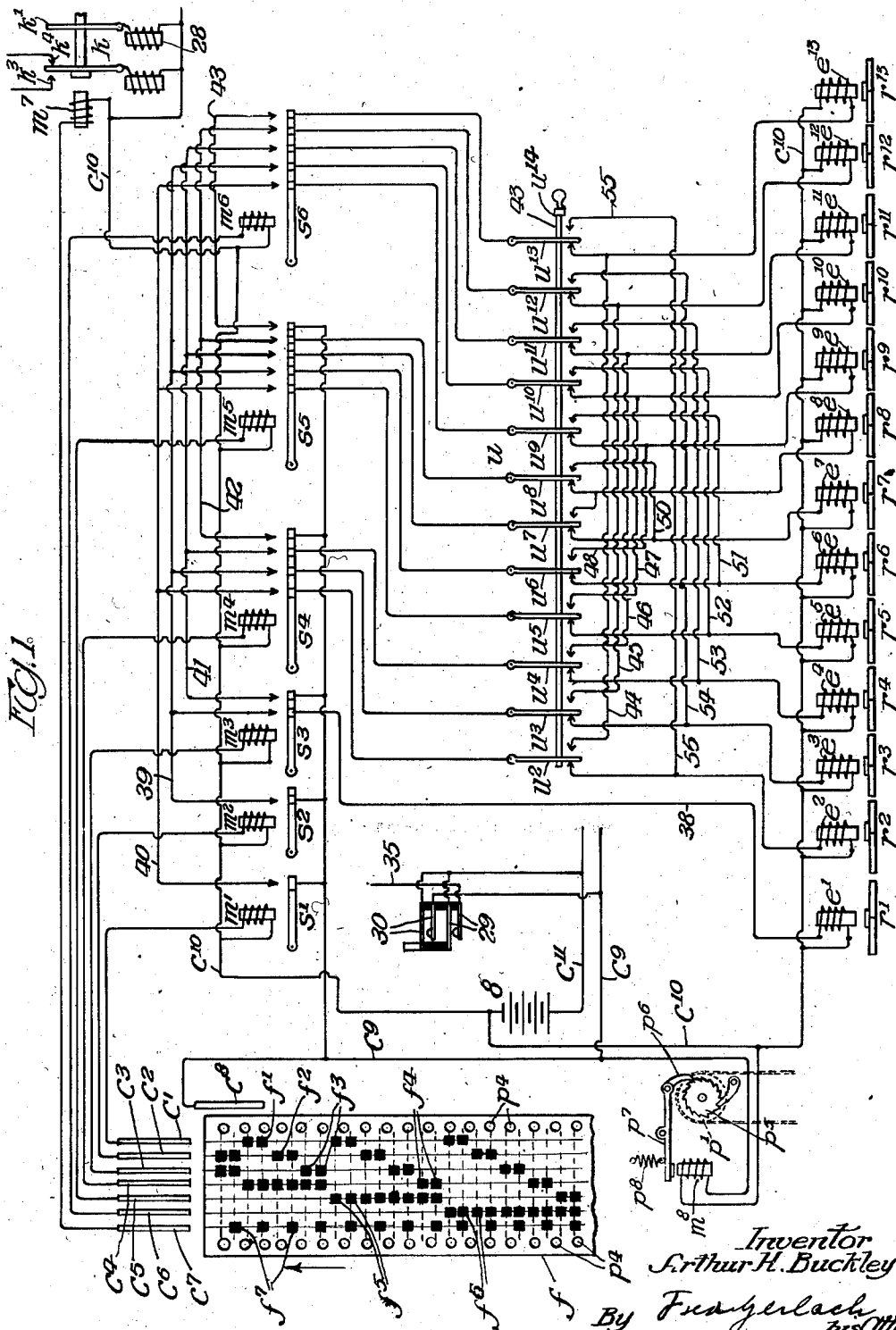
A. H. BUCKLEY

2,377,205

CRYPTOGRAPHIC EQUIPMENT

Filed Oct. 7, 1942

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May 29, 1945.

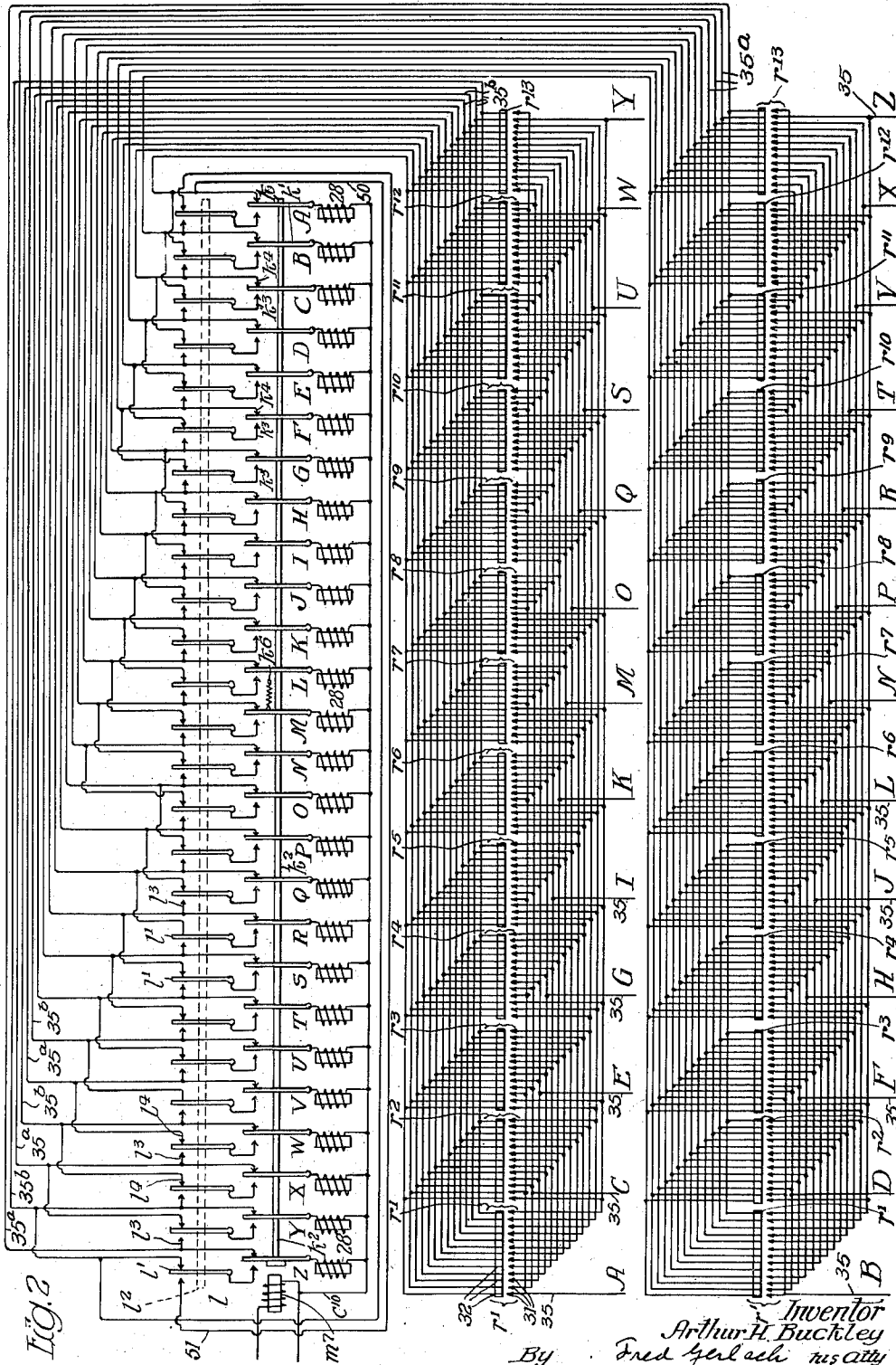
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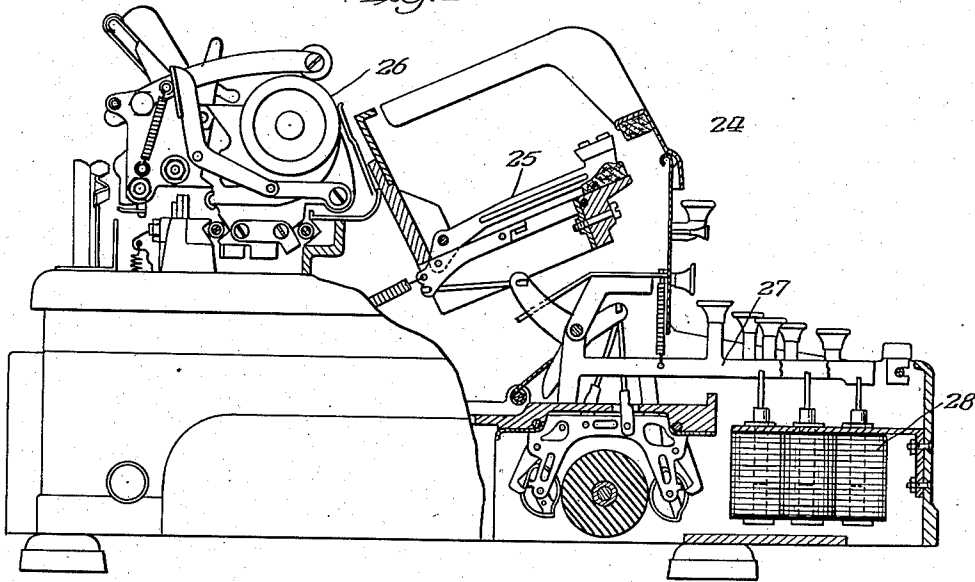
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CRYPTOGRAPHIC EQUIPMENT

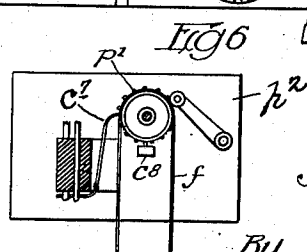
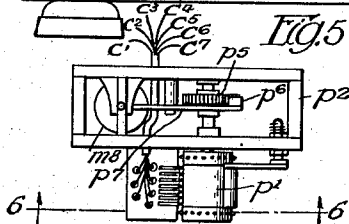
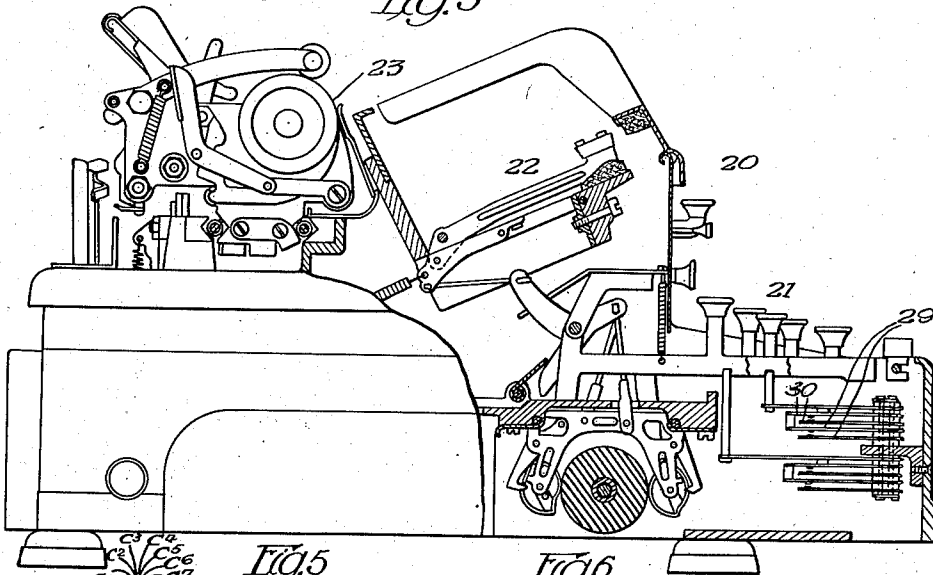
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*Fig. 2*



*Fig. 3*



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## UNITED STATES PATENT OFFICE

2,377,205

## CRYPTOGRAPHIC EQUIPMENT

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Application October 7, 1942, Serial No. 461,137

7 Claims. (Cl. 197—4)

The invention relates to cryptographic equipment.

One object of the invention is to provide equipment whereby a message in plain text while it is being printed will be translated into and printed as a cryptogram and the translation will be automatically controlled by code elements on a record, such for example as a perforated tape, and thereby dispensing with the necessity of reference to the code for the transmission, and facilitating and avoiding error in translation.

Another object of the invention is to provide equipment for printing the original text of a message from a cryptogram and automatically controlling the translation by the same or a like record, thereby facilitating and avoiding error in the printing of the translation from the cryptogram.

Another object of the invention is to provide improved equipment which is adapted to simultaneously print the text of a message and a cryptogram with mechanism for controlling through a record with code-elements the translation of the message into a cryptogram and the translation of the cryptogram into the original text of the message.

A still further object of the invention is to provide printing equipment which is adapted to encipher and decipher communications according to different codes.

Another object of the invention is to provide cryptographic equipment which is operable at a high rate of typewriting speed in enciphering and deciphering communications, which provides the maximum security against penetration and avoids accumulative errors.

Other objects of the invention will appear from the detailed description.

The invention consists in the several novel features which are hereinafter set forth and more particularly defined by claims at the conclusion hereof.

In the drawings:

Figure 1 is a diagrammatic illustration of the mechanism for automatically controlling the translation of the characters between a manually operated typewriting machine and an automatically controlled machine for printing the translation.

Figure 2 is a diagram of the electrical connections between the manually operable typewriting machine and the automatically controlled printing machine.

Figure 3 is a view, partly in section and partly

in elevation, of the typewriting machine in which the keys are manually operated.

Figure 4 is a view, partly in section and partly in elevation, of the printing machine which is controlled by the automatically controlled mechanism.

Figure 5 is a plan of the step by step feeding mechanism for the tape which is provided with code-elements.

Figure 6 is a section taken on line 6—6 of Figure 5.

The invention is exemplified in equipment which comprises a complete typewriting machine 20 which is manually and key operable; a printing machine 24, which may also be a complete typewriting machine, for simultaneously printing a translation of the matter typed on machine 20; a tape *f* which functions as a code and is provided with perforations according to the code used; and mechanism, controlled by the tape, for controlling the translation and selection of the letters or characters to be printed on the automatically controlled machine 24 responsively to the operation of the keys on machine 20.

Printing machine 24, illustrated in Fig. 4, is provided with a standard set of key-levers 27 and type-bars 25 respectively operable or controlled by the keys 27, and a platen 26 for holding a sheet on which the type-bars 25 will print. Key-levers 27 are operable by solenoids 28, respectively, which are selectively energized and controlled by automatic mechanism responsively to the depression of a key on machine 20.

The typewriting machine 20, illustrated in Fig. 3, is provided with a standard set of manually operable keys 21 having designations of the letters of the alphabet thereon, type-bars 22 controlled or operable by the keys respectively, in any well known manner, according to the designations for printing the letters on the keys 21.

The machines 20 and 24, as illustrated, are of standard motorized type and the printing mechanism may be of any suitable or usual construction. The finger-pieces on levers 27 of machine 24, which are operable by the solenoids 28, respectively, are not necessary for operation by the automatically controlling mechanism hereinafter described, but a complete standard typewriting machine on account of its availability.

The invention provides for the automatic selection and control of the solenoids 28 to translate a message typed in plain text on the machine 20 to a printed cryptogram on the machine 24 and also to translate the cryptogram typed on machine 20 to its original text on the machine

24. These translations are controlled by the code-elements on a tape *f* and mechanism controlled by the tape, during the depression of the keys for typing a message on machine 20.

Each key on machine 20 has associated therewith a pair of normally open switches 29 and 30 which are closed when the key is depressed in typing a letter on machine 20. Switches 29 control the flow of current from battery 8 via conductor *c*<sup>11</sup> for energizing the solenoids 28 for the individual operation of the key-levers 27 on machine 24 when the key 21 is depressed. The current from the solenoids 28 flows via a branch conductor *c*<sup>10</sup> to the negative side of battery 8. Switches 30 control the flow of current from battery 8 between conductor *c*<sup>11</sup> which is connected to the positive side of said battery, and a conductor *c*<sup>9</sup> to the code-connected mechanism hereinafter described, for controlling the mechanism for selectively controlling the operation of the solenoids 28 on the machine 24.

Conductors 35 lead from each of the key-controlled switches 29, respectively, for supplying current via the controlling mechanism hereinafter described to the solenoids 28 which automatically control the typing on the machine 24. In Fig. 2 the letters are indicated with the conductors 35 which are connected to said switches, and the letters which are printed on machine 24 through the energization of the solenoids 28 are indicated with the solenoids, respectively.

The mechanism for selectively controlling the operation of the solenoids 28 for shifting the key-levers 27 on machine 24 comprises a group *r* of thirteen normally open switches which are automatically controlled by the code-elements or perforations on the tape *f* by mechanism hereinafter described. This group *r* comprises switches designated *r*<sup>1</sup>, *r*<sup>2</sup>, *r*<sup>3</sup>, *r*<sup>4</sup>, *r*<sup>5</sup>, *r*<sup>6</sup>, *r*<sup>7</sup>, *r*<sup>8</sup>, *r*<sup>9</sup>, *r*<sup>10</sup>, *r*<sup>11</sup>, *r*<sup>12</sup>, *r*<sup>13</sup> each of which comprises two sections which are connected together. In Fig. 2 these sections are shown separated for clarity in illustration, although secured together for simultaneous closing by one of the electromagnets hereinafter described. Each section includes a set of thirteen stationary contacts 31 and a movable set of thirteen movable contacts 32 respectively engageable with the contacts 31. Each conductor 35 leading from thirteen of the key operable switches 29 is connected in arithmetical progression to thirteen sections of the group of switches *r* and each conductor 35 leading from the other thirteen switches 29 is connected in arithmetical progression to the contacts 31 of the other thirteen sections of the group of switches *r*, as illustrated in Fig. 2. For example, in the section of switch *r*<sup>1</sup> which is connected by a conductor 35 to the switch 29 associated with the key-lever 21 for printing the letter "A" on machine 20, the first contact 31 from the left is connected to the second contact of switch *r*<sup>2</sup>, the third contact 31 of the switch *r*<sup>3</sup>, the fourth contact 31 of the switch *r*<sup>4</sup>, the fifth contact 31 of the switch *r*<sup>5</sup>, the sixth contact 31 of the switch *r*<sup>6</sup>, the seventh contact 31 of the switch *r*<sup>7</sup>, the eighth contact 31 of switch *r*<sup>8</sup>, the ninth contact 31 of the switch *r*<sup>9</sup>, the tenth contact 31 of the switch *r*<sup>10</sup>, the eleventh contact 31 of the switch *r*<sup>11</sup>, the twelfth contact 31 of switch *r*<sup>12</sup>, and the thirteenth contact 31 of the switch *r*<sup>13</sup>. Each switch 29 is adapted, by means of these connections, to conduct current to one of the sections of all of the group of switches *r*.

The contacts 32 of one section of each of the thirteen switches of group *r* are connected in series and the contacts 32 of the other sections

of said switches are connected in series as illustrated in Fig. 2.

The connections between the switches of group *r* and the solenoids 28 include a switch *k* which comprises twenty-six movable members *k*<sup>1</sup> which are conjointly shiftable by a bar *k*<sup>2</sup>. The members *k*<sup>1</sup> of switch *k* are shiftable by an electromagnet *m*<sup>7</sup> which is automatically controlled by perforations *f*<sup>1</sup> in the tape *f*. Each switch-member *k*<sup>1</sup> is adapted alternately to engage contacts *k*<sup>4</sup> and *k*<sup>3</sup> and is normally held by a spring *k*<sup>6</sup> to engage a contact *k*<sup>4</sup>. When magnet *m*<sup>7</sup> is energized all of the members *k*<sup>1</sup> will be shifted into engagement with contacts *k*<sup>3</sup>, respectively. The alternating contacts *k*<sup>4</sup> of switch *k* are connected by conductors 35<sup>a</sup> and 35<sup>b</sup> to the series-connections between the sections of the thirteen switches of the group *r*. The switch *k* functions to connect each of the conductors 35<sup>a</sup>, 35<sup>b</sup> to either of 20 an adjacent pair of solenoids 28.

The connections between the group of switches *r* and the switch *k* include a switch *l* which comprises twenty-six movable member *l*<sup>1</sup> which are connected for conjoint manual shift by a bar *l*<sup>2</sup>. Said switch *l* provides a path for current from each of said conductors 35<sup>a</sup>, 35<sup>b</sup>, via a contact *l*<sup>3</sup> and a switch-member *l*<sup>1</sup> to the solenoid 28 to the right of the solenoid by contacts *k*<sup>3</sup>, *k*<sup>4</sup>, to which said conductors are connected when the switch-members *l*<sup>1</sup> engage contacts *k*<sup>4</sup>. The switch *l* functions to change the selection of solenoids 28 which are energized when the keys 21 are depressed, for use in translating a cryptogram printed on machine 20 for typing the original text on the machine 20, as hereinafter described.

The connections between the key operable switches 29 and the solenoids 28 for controlling the printing operations on the machine 24, make it possible to selectively control the operation of 40 any of the solenoid magnets 28 so that each key 21 on the machine 20 may control the printing of any letter of the alphabet on machine 24.

A group *e* comprising electromagnets *e*<sup>1</sup>, *e*<sup>2</sup>, *e*<sup>3</sup>, *e*<sup>4</sup>, *e*<sup>5</sup>, *e*<sup>6</sup>, *e*<sup>7</sup>, *e*<sup>8</sup>, *e*<sup>9</sup>, *e*<sup>10</sup>, *e*<sup>11</sup>, *e*<sup>12</sup>, *e*<sup>13</sup> which function 45 to close the switches *r*<sup>1</sup>, *r*<sup>2</sup>, *r*<sup>3</sup>, *r*<sup>4</sup>, *r*<sup>5</sup>, *r*<sup>6</sup>, *r*<sup>7</sup>, *r*<sup>8</sup>, *r*<sup>9</sup>, *r*<sup>10</sup>, *r*<sup>11</sup>, *r*<sup>12</sup>, *r*<sup>13</sup> of the group *r*, respectively. This series of magnets is selectively controlled by the perforations in the tape *f*.

The mechanism for automatically and selectively controlling, from the tape, the magnets of group *e* to close the switches of group *r* comprises: a series of permutably closable switches *s*<sup>1</sup>, *s*<sup>2</sup>, *s*<sup>3</sup>, *s*<sup>4</sup>, *s*<sup>5</sup>, *s*<sup>6</sup>; a series of switch-contacts *c*<sup>1</sup>, *c*<sup>2</sup>, *c*<sup>3</sup>, *c*<sup>4</sup>, *c*<sup>5</sup>, *c*<sup>6</sup>, *c*<sup>7</sup> which are adapted to receive 55 current through the perforations in tape *f*; a series of electromagnets *m*<sup>1</sup>, *m*<sup>2</sup>, *m*<sup>3</sup>, *m*<sup>4</sup>, *m*<sup>5</sup>, *m*<sup>6</sup>, *m*<sup>7</sup> which are controlled respectively by the contacts which receive current through said perforations; mechanism for advancing the tape one step after each printing operation; and a group *u* of manually shiftable switch-members *u*<sup>2</sup>, *u*<sup>3</sup>, *u*<sup>4</sup>, *u*<sup>5</sup>, *u*<sup>6</sup>, *u*<sup>7</sup>, *u*<sup>8</sup>, *u*<sup>9</sup>, *u*<sup>10</sup>, *u*<sup>11</sup>, *u*<sup>12</sup>, *u*<sup>13</sup>, which are connected for simultaneous shift by a bar *u*<sup>14</sup>, and connections between the group of switches *u* and the 65 group of magnets *e* for varying the selection in group *e* when the machines 20, 24 are used for translating a cryptogram to the original text of the message.

The tape *f* is advanced one step following each depression of a key 21 on machine 20 by a drum *p*<sup>1</sup> which is provided with sprocket teeth for engaging perforations *p*<sup>4</sup> in the tape *f*. Drum *p*<sup>1</sup> is journaled in a frame *p*<sup>2</sup> and is rotated step-by-step by mechanism comprising a ratchet wheel 70 *p*<sup>5</sup>, a pawl *p*<sup>6</sup>, a pivot lever *p*<sup>7</sup>, and a spring *p*<sup>8</sup>

which imparts the drum-advancing stroke to said pawl. Lever  $p^7$  is shifted for the idle stroke of said pawl by an electromagnet  $m^8$  which is connected to receive current from switches 30 via the conductor  $c^9$ . A conductor  $c^{10}$  leads from magnet  $m^8$  to the negative side of the battery 8. This mechanism advances the tape one step after each depression of a key 21 of machine 20.

The perforations in the tape  $f$  are permutably arranged along seven longitudinal lines for engagement with the drum of switch-contacts  $c^1$ ,  $c^2$ ,  $c^3$ ,  $c^4$ ,  $c^5$ ,  $c^6$ ,  $c^7$ , respectively. A switch contact  $c^8$  constantly contacts the drum and is connected to receive current from the conductor  $c^9$  through the key-operable switches 30. Current from the drum  $p^1$  passes: to switch-contact  $c^1$ , through the perforations  $f^1$  in the tape  $f$ , for energizing magnet  $m^1$  which shifts the switch  $s^1$ ; to switch-contact  $c^2$  through the perforations  $f^2$  in the tape  $f$ , for energizing magnet  $m^2$  which shifts the switch  $s^2$ ; to switch-contact  $c^3$ , through the perforations  $f^3$  in the tape  $f$ , for energizing magnet  $m^3$  which shifts the switch  $s^3$ ; to switch-contact  $c^4$  through the perforations  $f^4$  in the tape  $f$ , for energizing magnet  $m^4$  which shifts the switch  $s^4$ ; to switch-contact  $c^5$ , through the perforations  $f^5$  in the tape  $f$ , for energizing magnet  $m^5$  which shifts the switch  $s^5$ ; to switch-contact  $c^6$ , through the perforations  $f^6$  in the tape  $f$ , for energizing magnet  $m^6$  which shifts the switch  $s^6$ ; and to switch-contact  $c^7$ , through perforations  $f^7$  in the tape  $f$ , for energizing the electromagnet  $m^7$  which is adapted to shift the switch  $k$ . The perforations  $f^1$ ,  $f^2$ ,  $f^3$ ,  $f^4$ ,  $f^5$ ,  $f^6$  in the tape are transversely aligned in pairs so they will coact to simultaneously energize a pair of electromagnets  $m^1$ ,  $m^2$ ,  $m^3$ ,  $m^4$ ,  $m^5$ ,  $m^6$ , for example  $m^2$  and  $m^3$ ;  $m^1$  and  $m^4$ ;  $m^2$  and  $m^4$ ;  $m^3$  and  $m^4$ ;  $m^1$  and  $m^5$ ;  $m^2$  and  $m^5$ ;  $m^3$  and  $m^5$ ;  $m^4$  and  $m^5$ ;  $m^1$  and  $m^6$ ;  $m^2$  and  $m^6$ ;  $m^3$  and  $m^6$ ;  $m^4$  and  $m^6$ ; and  $m^5$  and  $m^6$ . Each pairing is adapted to permutably control the closing of a pair of the  $s$  series of switches for circuits for energizing the electromagnets of the  $e$  series, respectively. The perforations  $f^7$  in the tape are arranged longitudinally with transversely aligned alternately successive pairs of the perforations which control the magnets  $m^1$  to  $m^6$ , inclusive, or two steps apart so that contact  $c^7$  will receive current from the drum at alternate stations for energizing the magnet  $m^7$  to shift switch  $k$  during alternate depressions of the keys 21.

With the code perforations illustrated in the tape  $f$  in Fig. 1, the switches  $s^1$ ,  $s^2$ ,  $s^3$ ,  $s^4$ ,  $s^5$ ,  $s^6$  can be permutably closed by the electromagnets  $m^1$ ,  $m^2$ ,  $m^3$ ,  $m^4$ ,  $m^5$ ,  $m^6$  for selectively controlling the solenoids 28 of machine 24, as follows: When switches  $s^2$ ,  $s^3$  which are controlled by a pair of perforations  $f^2$ ,  $f^3$ , are closed, current will pass from the battery 8, via conductor  $c^{11}$ , the switch 30 closed by the depressed key, conductor  $c^9$ , switch  $s^2$ , conductor 39, the left hand contacts of switch  $s^3$ , and conductor 38 to energize magnet  $e^1$  and close switch  $r^1$  while the contacts  $k^1$ ,  $k^4$  of switch  $k$  are engaged; when switches  $s^2$ ,  $s^3$  are closed, and electromagnet  $m^7$ , which is controlled by perforation  $f^7$ , is simultaneously energized, switch  $r^1$  will be closed in the same manner and switch  $k$  will be automatically shifted to engage contacts  $k^1$ ,  $k^3$  and vary the selection of the solenoid 28; when switches  $s^1$ ,  $s^4$ , which are controlled by a pair of perforations  $f^1$ ,  $f^4$ , are closed, current will flow via conductor  $c^9$ , from the depressed switch 30, switch  $s^1$ , conductor 40, the left hand contacts of switch  $r$ , and switch  $u^2$ ,

to energize magnet  $e^2$  which will close switch  $r^2$  while the contacts  $k^1$ ,  $k^4$  of switch  $k$  are engaged; when switches  $s^1$ ,  $s^4$  are closed in the same manner and magnet  $m^7$  is simultaneously energized, switch  $k$  will be shifted to engage contacts  $k^1$ ,  $k^3$ ; when switches  $s^2$ ,  $s^4$ , which are controlled by perforations  $f^2$ ,  $f^4$ , are closed, current will flow from the depressed switch 30, via conductor  $c^9$ , switch  $s^2$ , the second contacts from the left of switch  $r^4$ , switch  $u^3$ , to energize magnet  $e^3$  which will close switch  $r^3$  while the contacts  $k^1$ ,  $k^4$  of switch  $k$  are engaged; when switches  $s^2$ ,  $s^4$  are closed in the same manner and magnet  $m^7$ , which is controlled by a perforation  $f^7$ , is energized, switch  $r^3$  will be closed and switch  $k$  will be shifted to engage contacts  $k^1$ ,  $k^3$ ; when switches  $s^3$ ,  $s^4$ , which are controlled by perforations  $f^3$ ,  $f^4$ , are closed, current will pass from the closed switch 30, via conductor  $c^9$ , the right hand contacts of switch  $s^3$ , the second contacts from the right of switch  $s^4$ , switch  $u^4$ , to energize magnet  $e^4$  which will close switch  $r^4$  while the contacts  $k^1$ ,  $k^4$  of switch  $k$  are engaged; when switches  $s^3$ ,  $s^4$  are closed and magnet  $m^7$  is simultaneously energized, switch  $r^4$  will be closed in the same manner and switch  $k$  will be shifted to engage contacts  $k^1$ ,  $k^3$ ; when switches  $s^1$ ,  $s^5$ , which are controlled by perforations  $f^1$ ,  $f^5$ , are closed, current will flow from the closed switch 30, via conductor  $c^9$ , switch  $s^1$ , conductor 40, the first contacts at the left of switch  $s^5$ , switch  $u^5$ , to energize magnet  $e^5$  which will close switch  $r^5$  while the contacts  $k^1$ ,  $k^4$  of switch  $k$  are engaged; when switches  $s^1$ ,  $s^5$  are closed, and magnet  $m^7$ , which is controlled by perforation  $f^7$ , is simultaneously energized, switch  $r^5$  will be closed in the same manner and switch  $k$  will be shifted to engage contacts  $k^1$ ,  $k^3$ ; when switches  $s^2$ ,  $s^5$ , which are controlled by perforations  $f^2$ ,  $f^5$ , are closed, current will flow from the closed switch 30, via conductor  $c^9$ , switch  $s^2$ , conductor 40, the second contacts from the left of switch  $s^5$ , and switch  $u^6$ , to energize magnet  $e^6$  to close switch  $r^6$  while the contacts  $k^1$ ,  $k^4$  of switch  $k$  remain engaged; when switches  $s^2$ ,  $s^5$  are closed, and magnet  $m^7$  is simultaneously energized, switch  $r^6$  will be closed in the same manner and switch  $k$  will be shifted to engage contacts  $k^1$ ,  $k^3$ ; when switches  $s^3$ ,  $s^5$ , which are controlled by perforations  $f^3$ ,  $f^5$ , are closed, current will flow from the closed switch 30, via conductor  $c^9$ , the right hand contacts of switch  $s^3$ , conductor 41, the third contacts from the left of switch  $s^5$ , and switch  $u^7$ , to energize magnet  $e^7$  which will close switch  $r^7$  while the contacts  $k^1$ ,  $k^4$  remain engaged; when switches  $s^3$ ,  $s^5$  are closed, and magnet  $m^7$  is simultaneously energized, switch  $r^7$  will be closed in the same manner and switch  $k$  will be shifted to engage contacts  $k^1$ ,  $k^3$ ; when switches  $s^4$ ,  $s^5$ , which are controlled by perforations  $f^4$ ,  $f^5$ , are closed, current will flow from the closed switch 30, via conductor  $c^9$ , the right hand contacts of switch  $s^4$ , conductor 42, the second contacts from the right of switch  $s^4$ , and switch  $u^8$ , to energize magnet  $e^8$  which will close switch  $r^8$  while the contacts  $k^1$ ,  $k^4$  of switch  $k$  remain engaged; when switches  $s^4$ ,  $s^5$  are closed, and magnet  $m^7$  is simultaneously energized, switch  $r^8$  will be closed in the same manner and switch  $k$  will be shifted to engage contacts  $k^1$ ,  $k^3$ ; when the switches  $s^1$ ,  $s^6$ , which are controlled by perforations  $f^1$ ,  $f^6$ , are closed, current will flow from the closed switch 30, via conductor  $c^9$ , switch  $s^1$ , conductor 40, the first contacts to the left of switch  $s^6$ , and switch  $u^9$ , to magnet  $e^9$  which will close switch  $r^9$  while the contacts  $k^1$ ,  $k^4$  of switch  $k$  remain engaged; when switches  $s^1$ ,  $s^6$  are closed

and magnet  $m^7$  is simultaneously energized, switch  $r^0$  will be closed in the same manner and switch  $k$  will be shifted to engage contacts  $k^1, k^3$ ; when switches  $s^2, s^6$ , which are controlled by perforations  $f^2, f^6$ , are closed, current will flow from the closed switch 30, via conductor  $c^9$ , switch  $s^2$ , conductor 39, to the second contacts from the left of switch  $s^6$ , and switch  $u^{10}$ , to magnet  $e^{10}$  which will close switch  $r^{10}$  while contacts  $k^1, k^4$  of switch  $k$  remain engaged; when switches  $s^2, s^6$  are closed, and magnet  $m^7$  which is controlled by a perforation  $f^7$ , is energized, switch  $r^{10}$  will be closed in the same manner and switch  $k$  will be shifted to engage contacts  $k^1, k^3$ ; when switches  $s^3, s^6$ , which are controlled by perforations  $f^3, f^6$ , are closed, current will flow from the closed switch 30, via conductor  $c^9$ , the right hand contacts of switch  $s^4$ , conductor 42, the second contacts from the right of switch  $s^6$ , and switch  $u^{12}$ , to energize magnet  $e^{12}$  which will close switch  $r^{12}$ , while contacts  $k^1, k^4$  of switch  $k$  remain energized. When switches  $s^4, s^6$  are closed, and magnet  $m^7$ , which is controlled by perforations  $f^7$ , is simultaneously energized, switch  $r^{12}$  will be closed in the same manner and switch  $k$  shifted to engage contacts  $k^1, k^3$ ; when switches  $s^5, s^6$ , which are controlled by perforations  $f^5, f^6$ , are closed current will flow from the closed switch 30, via conductor  $c^9$ , the right hand contacts of switch  $s^5$ , conductor 43, the right hand contacts of switch  $s^6$ , and switch  $u^{13}$  to energize magnet  $e^{13}$  which will close switch  $r^{13}$  while contacts  $k^1, k^4$  of switch  $k$  remain engaged. When switches  $s^5, s^6$  are closed, and magnet  $m^7$ , which is controlled by a perforation  $f^7$ , is simultaneously energized, switch  $r^{13}$  will be closed in the same manner and switch  $k$  will be shifted to engage contacts  $k^1, k^3$ . The tape  $f$  is formed of insulating material so that current will pass from the drum to the contacts  $c^1, c^2, c^3, c^4, c^5, c^6, c^7$  only when the perforations permit them to engage the drum.

To exemplify the variations in the letters which may be printed on the machine 24 in response to the depression of a key on machine 20 through the automatic and selective tape or code-controlled mechanism, the selection or printing of the letters of the alphabet on machine 24 will next be described in connection with the key-lever for printing "A" on machine 20, which is controlled by the upper sections of the group of switches shown in Fig. 2.

With the code on the tape  $f$  illustrated in Fig. 1, the depression of the key 21 for printing "A" on machine 20 while contacts  $c^2$  and  $c^3$  engage the drum  $p^1$  through perforations  $f^2, f^3$ , at the closed switch 30, close circuits for energizing magnets  $m^2$  and  $m^3$  to close switches  $s^2, s^3$  for energizing the magnet  $e^1$  to shift switch  $r^1$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , switch  $s^2$ , conductor 39, the left hand contact on switch  $s^3$ , electromagnet  $e^1$ , and conductor  $c^{10}$ . Switch  $r^1$  will then establish a circuit from conductor  $c^{11}$ , via the closed switch 29, a conductor 35, the left hand pair of contacts on the upper section of switch  $r^1$ , a conductor 35<sup>a</sup>, a contact  $k^4$ , a switch-member  $k^1$ , for energizing the magnet 28 which operates the key-lever 27 for printing the letter "A" on the machine 24. The tape  $f$  is advanced one step when the depressed key 21 is released, and perforations  $f^2, f^3, f^7$  will be moved into position for engagement of switch-contacts  $c^2, c^3$  and  $c^7$  with the drum  $p^1$ . The next depression of the same key 21 will cause the magnet  $e^1$  to be ener-

gized to shift switch  $r^1$  as before described, and electromagnet  $m^7$  will receive current via contact  $c^7$  and hold the switch  $k$  in its alternate position to engage contacts  $k^3$ . Current will then flow from the closed switch 29, via a conductor 35, the left hand pair of contacts on the upper section of switch  $r^1$ , conductors 35<sup>a</sup> and 50, a contact  $k^4$ , switch member  $k^1$ , a contact  $k^3$ , and a switch-member  $k^1$ , to energize the solenoid 28 for causing the letter "Z" to be printed on machine 24.

When the key 21 for printing "A" on machine 20 is next depressed, contacts  $c^1$  and  $c^4$  will receive current from drum  $p^1$  through perforations  $f^1, f^4$  and magnets  $m^1$  and  $m^4$  will be energized to close switches  $s^1$  and  $s^4$  for energizing the magnet  $e^2$  to shift switch  $r^2$  through the following circuit from the switch 29 which is closed by the depressed key: conductor  $c^9$ , switch  $s^1$ , conductor 40, the left hand contact on switch  $s^4$ , switch  $u^2$ , electromagnet  $e^2$ , and conductor  $c^{10}$ . Switch  $r^2$  will then be closed to establish a circuit from conductor  $c^{11}$ , via the closed switch 29, a conductor 35, the second pair of contacts from the left of switch  $r^2$ , a conductor 35<sup>a</sup>, a contact  $k^4$ , and a switch-member  $k^1$  for energizing the magnet 28 which shifts the key-lever 27 which causes the letter "C" to be printed on the machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that a perforation  $f^7$  will permit switch-contact  $c^7$  to receive current from the drum  $p^1$  to energize magnet  $m^7$  and contacts  $c^1, c^4$  will also receive current through perforations  $f^1, f^4$ . The next depression of the same key 21 will cause the magnet  $e^2$  to be energized to shift switch  $r^2$  as before described and electromagnet  $m^7$  is energized by current from contact  $c^7$  to hold the switch  $k$  in its alternative position. Current will then flow via the second pair of contacts from the left of switch  $r^2$ , a contact  $k^4$ , a switch  $u^2$ , a contact  $k^3$ , switch member  $k^1$  and energize the magnet 28 which operates the key-lever for printing "B" on machine 24. Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations  $f^2, f^4$  to the contacts  $c^2, c^4$ .

If the key 21 for printing "A" on machine 20 is next depressed, contacts  $c^2, c^4$  will receive current from drum  $p^1$  through perforations  $f^2, f^4$  so that magnets  $m^2, m^4$  will be energized and close switches  $s^2, s^4$  for energizing the magnet  $e^3$  to shift switch  $r^3$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , switch  $s^1$ , conductor 39, the second contact from the left on switch  $s^4$ , switch  $u^3$ , electromagnet  $e^3$ , and conductor  $c^{10}$ . Switch  $r^3$  will then be closed to establish a circuit via conductor  $c^{11}$ , the closed switch 29, a conductor 35, the third pair of contacts from the left on contact switch  $r^3$ , a conductor 35<sup>a</sup> and a contact  $k^4$  for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "E" on machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that a perforation  $f^7$  will be in position to permit switch-contact  $c^7$  to engage the drum  $p^1$  to energize magnet  $m^7$  and contacts  $c^1, c^4$  can receive current through perforations  $f^1, f^4$ . The next depression of the same key 21 will cause the magnet  $e^3$  to be energized to shift switch  $r^3$  as before described and the electromagnet  $m^7$  to receive current from contact  $c^7$  and hold the switch  $k$  in a position to engage contacts  $k^3$ . Current will then flow via the third pair of contacts from the left of



switch  $r^3$ , a conductor  $35^a$ , a contact  $l^3$  a switch member  $l'$ , a contact  $k^3$  and a switch-member  $k^1$ , for energizing that magnet 28 which operates the key-lever 27 for printing "F" on machine 24. Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations  $f^3$ ,  $f^4$  to the contacts  $c^3$ ,  $c^4$ .

If the key 21 for printing "A" on machine 20 is then depressed, contacts  $c^3$ ,  $c^4$  will receive current from drum  $p^1$  through perforations  $f^3$ ,  $f^4$  so that magnets  $m^3$ ,  $m^4$  will be energized and close switches  $s^3$ ,  $s^4$  for energizing the magnet  $e^4$  to shift switch  $r^4$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$  switch  $s^1$ , conductor 39, the second contact from the left on switch  $s^4$ , switch  $u^4$ , electromagnet  $e^4$ , and conductor  $c^{10}$ . Switch  $r^4$  will then establish a circuit from conductor  $c^{11}$ , via the closed switch 29, a conductor 35, the fourth pair of contacts from the left of switch  $r^4$ , a conductor  $35^a$ , and a contact  $k^4$  for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "G" on machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that perforation  $f^1$  will permit switch-contact  $c^7$  to engage the drum  $p^1$  and contacts  $c^3$  and  $c^4$  will receive current through perforations  $f^3$  and  $c^4$ . The next depression of the same key 21 will cause the magnet  $e^4$  to be energized to shift switch  $r^4$  as before described and the electromagnet  $m^7$  to receive current from contact  $c^7$  and the switch  $k$  in a position to engage contacts  $k^3$ . Current will then flow via the fourth pair of contacts from the left of switch  $r^4$ , a conductor  $35^a$ , a contact  $l^3$ , a switch-member  $l'$ , a contact  $k^3$ , and a switch-member  $k^1$  for energizing the magnet 28 which shifts the key-lever 27 for printing the letter "H" on machine 24. Upon release of key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations  $f^1$ ,  $f^5$  to the contacts  $c^1$ ,  $c^5$ .

If the key 21 for printing "A" on machine 20 is again depressed, contacts  $c^1$ ,  $c^5$  will receive current from drum  $p^1$  through perforations  $f^1$ ,  $f^5$  so that magnets  $m^1$ ,  $m^5$  will be energized and close switches  $s^1$ ,  $s^5$  for energizing the magnet  $e^5$  to shift switch  $r^5$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , switch  $s^1$ , conductor 40, the left hand contact on switch  $s^5$ , switch  $u^5$ , electromagnet  $e^5$ , and conductor  $c^{10}$ . Switch  $r^5$  will then establish a circuit from conductor  $c^{11}$ , via the closed switch 29, a conductor 35, the fifth pair of contacts from the left of contact switch  $r^5$ , a conductor  $35^a$  and a contact  $k^4$  for energizing that magnet 28 which is connected to the key-lever 27 for printing the letter "I" on machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that a perforation  $f^1$  will be in position to permit switch-contact  $c^7$  to engage the drum  $p^1$  and contacts  $c^1$  and  $c^5$  will receive current through perforations  $f^1$  and  $f^5$ . The next depression of the same key 21 will cause the magnet  $e^5$  to be energized to shift switch  $r^5$  as before described and electromagnet  $m^7$  to receive current from contact  $c^7$  and hold the switch  $k$  in position to engage contacts  $k^3$ . Current will then flow via the fifth pair of contacts from the left of switch  $r^5$ , a conductor  $35^a$ , a contact  $l^3$ , a switch member  $l'$ , a contact  $k^3$ , and a switch-member  $k^1$  for energizing the magnet 28 for operating the key-lever

for printing the letter "J" on machine 24. Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations  $f^2$ ,  $f^5$  to the contacts  $c^2$ ,  $c^5$ .

If the key 21 for printing "A" on machine 20 is again depressed, contacts  $c^2$ ,  $c^5$  will receive current from drum  $p^1$  through perforations  $f^2$ ,  $f^5$  so that magnets  $m^2$ ,  $m^5$  will be energized and close switches  $s^2$ ,  $s^5$  for energizing the magnet  $e^6$  to shift switch  $r^6$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , switch  $s^2$ , conductor 39, the left hand contact on switch  $s^5$ , switch  $u^6$ , electromagnet  $e^6$ , and conductor  $c^{10}$ . Switch  $r^6$  will then establish a circuit from conductor  $c^{11}$ , via closed switch 29, a conductor 35, the sixth pair of contacts from the left of contact-switch  $r^6$ , a conductor  $35^a$ , and a contact  $k^4$  for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "K" on the machine 24. The tape  $f$  is advanced one step when the depressed key 21 is released, so that a perforation  $f^1$  will permit switch-contact  $c^7$  to receive current through perforations  $f^2$  and  $f^5$ . The next depression of the same key 21 will cause the magnet  $e^6$  to be energized to shift switch  $r^6$  as before described and electromagnet  $m^7$  to receive current from contact  $c^7$  and hold the switch  $k$  in position to engage contacts  $k^3$ . Current will then flow via the sixth pair of contacts from the left of switch  $r^6$ , a conductor  $35^a$ , a contact  $l^3$ , a switch-member  $l'$ , a contact  $k^3$ , and a switch-member  $k^1$  for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "L" on machine 24. Upon release of said key-lever 21, the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations  $f^3$ ,  $f^5$  to the contacts  $c^3$ ,  $c^5$ .

If the key 21 for printing "A" on machine 20 is next depressed, contacts  $c^3$ ,  $c^5$  will receive current from drum  $p^1$  through perforations  $f^3$ ,  $f^5$  so that magnets  $m^3$ ,  $m^5$  will be energized and close switches  $s^3$ ,  $s^5$  for energizing the magnet  $e^7$  to shift switch  $r^7$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , the right hand contact of switch  $s^3$ , conductor 41, the third contact from the left on switch  $s^4$ , switch  $u^7$ , electromagnet  $e^7$ , and conductor  $c^{10}$ . Switch  $r^7$  will then be closed to establish a circuit from conductor  $c^{11}$ , via the closed switch 29, a conductor 35, the seventh pair of contacts from the left of contact-switch  $r^7$ , a conductor  $35^a$  and a contact  $k^4$  for energizing that magnet 28 which is connected to the lever 27 for printing the letter "M" on the machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that a perforation  $f^1$  will permit switch-contact  $c^7$  to receive current from the drum  $p^1$  to energize magnet  $m^7$  and contacts  $c^3$ ,  $c^5$  to receive current through perforations  $f^3$ ,  $f^5$ . The next depression of the same key 21 will cause the magnet  $e^7$  to be energized to shift switch  $r^7$  as before described and electromagnet  $m^7$  to receive current from contact  $c^7$  to hold the switch  $k$  in position to engage contacts  $k^3$ . Current will then flow via the seventh pair of contacts from the left on switch  $r^7$ , a conductor  $35^a$ , a contact  $l^3$ , a switch-member  $l'$ , a contact  $k^3$ , and a switch-member  $k^1$ , for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "N" on machine 24. Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the



next transversely aligned perforations  $f^4, f^5$  to the contacts  $c^4, c^5$ .

If the key 21 for printing "A" on machine 20 is next depressed, contacts  $c^4, c^5$  will receive current from drum  $p^1$  through perforations  $f^4, f^5$ , so that magnets  $m^4, m^5$  will be energized and close switches  $s^4, s^5$  for energizing the magnet  $e^7$  to shift switch  $r^3$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , the right hand contact of switch  $s^4$ , conductor 42, the third contact from the left on switch  $s^5$ , switch  $u^8$ , electro-magnet  $e^9$ , and conductor  $c^{10}$ . Switch  $r^3$  will then be closed to establish a circuit from conductor  $c^{11}$ , via the closed switch 29, a conductor 35, the eighth pair of contacts from the left of contact-switch  $r^3$ , and a conductor 35<sup>a</sup> for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "O" on the machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that a perforation  $f^7$  will permit switch-contact  $c^7$  to receive current from the drum  $p^1$  to energize magnet  $m^7$  and contacts  $c^4, c^5$  to receive current through perforations  $f^4, f^5$ . The next depression of the same key 21 will cause the magnet  $e^8$  to be energized to shift switch  $r^3$  as before described and electromagnet  $m^7$  to receive current from contact  $c^7$  to hold the switch  $k$  in position to engage contacts  $k^3$ . Current will then flow via the eighth pair of contacts from the left on switch  $r^3$ , a conductor 35<sup>a</sup>, a contact  $l^3$ , a switch-member  $l^1$ , a contact  $k^3$ , and a switch-member  $k^1$  for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "P" on machine 24. Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations  $f^1, f^6$  to the contacts  $c^1, c^6$ .

If the key 21 for printing "A" on machine 20 is next depressed, contacts  $c^1, c^6$  will receive current from drum  $p^1$  through perforations  $f^1, f^6$  so that the magnets  $m^1, m^6$  will be energized and close switches  $s^1, s^6$  for energizing the magnet  $e^9$  to shift switch  $r^9$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , switch  $s^1$ , conductor 40, the left hand contact on switch  $s^4$ , switch  $u^9$ , electromagnet  $e^9$ , and conductor  $c^{10}$ . Switch  $r^9$  will then be closed to establish a circuit from conductor  $c^{11}$  via the closed switch 29, a conductor 35, the ninth pair of contacts from the left of contact switch  $r^9$ , a conductor 35<sup>a</sup>, and a contact  $k^4$  for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "Q" on the machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that a perforation  $f^7$  will permit switch-contact  $c^7$  to receive current from the drum  $p^1$  and contacts  $c^1, c^6$  will receive current through perforations  $f^1, f^6$ . The next depression of the same key 21 will cause the magnet  $e^9$  to be energized to shift switch  $r^9$  as before described and electromagnet  $m^7$  to receive current from contact  $c^7$  to hold the switch  $k$  in position to engage contacts  $k^3$ . Current will then flow via the ninth pair of contacts from the left on switch  $r^9$ , a conductor 35<sup>a</sup>, a contact  $l^3$ , a switch  $l^1$ , a contact  $k^3$ , a switch-member  $k^1$ , and energize that magnet 28 which is connected to shift the key-lever 27 for printing the letter "R" on machine 24. Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations  $f^2, f^6$  to contacts  $c^2, c^6$ .

If the key for printing "A" on machine 20 is

next depressed, contacts  $c^2, c^6$  will receive current from drum  $p^1$  through perforations  $f^2, f^6$ , so that magnets  $m^2, m^6$  will be energized and close switches  $s^2, s^6$  for energizing the magnet  $e^7$  to shift switch  $r^{10}$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , switch  $s^2$ , conductor 39, the second contact from the left on switch  $s^5$ , switch  $u^{10}$ , electromagnet  $e^{10}$ , and conductor  $c^{10}$ . Switch  $r^{10}$  will then be closed to establish a circuit from conductor  $c^{11}$ , via the closed switch 29, a conductor 35, the eleventh pair of contacts from the left of contact-switch  $r^{10}$ , a conductor 35, and a contact  $k^4$ , for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "S" on the machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that a perforation  $f^7$  will permit switch-contact  $c^7$  to receive current from the drum  $p^1$  to energize magnet  $m^7$  and contacts  $c^2, c^6$  to receive current through perforations  $f^2, f^6$ . The next depression of the same key 21 will cause the magnet  $e^{10}$  to be energized to shift switch  $r^{10}$  as before described and electromagnet  $m^7$  to receive current from contact  $c^7$  to hold the switch  $k$  in position to engage contacts  $k^3$ . Current will then flow via the tenth pair of contacts from the left on switch  $r^{10}$ , a contact  $l^3$ , a switch  $l^1$ , a contact  $k^3$ , a switch-member  $k^1$ , and energize that magnet 28 which is connected to shift the key-lever 27 for printing the letter "T" on machine 24. Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations  $f^3, f^6$  to the contacts  $c^3, c^6$ .

If the key for printing "A" on machine 20 is next depressed, contacts  $c^3, c^6$  will receive current from drum  $p^1$  through perforations  $f^3, f^6$ , so that magnets  $m^3, m^6$  will be energized and close switches  $s^3, s^6$  for energizing the magnet  $e^{11}$  to shift switch  $r^{11}$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , the right hand contact of switch  $s^3$ , conductor 41, the third contact from the left on switch  $s^6$ , switch  $u^{11}$ , electromagnet  $e^{11}$ , a conductor  $c^{10}$ . Switch  $r^{11}$  will then be closed to establish a circuit from conductor  $c^{11}$ , via the closed switch 29, a conductor 35, the eleventh pair of contacts from the left of switch  $r^{11}$ , a conductor 35<sup>a</sup> and a contact  $k^4$  for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "U" on the machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that a perforation  $f^7$  will permit switch-contact  $c^7$  to receive current from the drum  $p^1$  to energize magnet  $m^7$  and contacts  $c^3, c^6$  to receive current through perforations  $f^3, f^6$ . The next depression of the same key 21 will cause the magnet  $e^{11}$  to be energized to shift switch  $r^{11}$  as before described and electromagnet  $m^7$  to receive current from contact  $c^7$  to hold the switch  $k$  in position to engage contact  $k^3$ . Current will then flow via the eleventh pair of contacts from the left on switch  $r^{11}$ , a contact  $l^3$ , a switch  $l^1$ , a contact  $k^3$ , switch-member  $k^1$ , and energize that magnet 28 which is connected to shift the key-lever 27 for printing the letter "V" on machine 24. Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations  $f^4, f^6$  to the contacts  $c^4, c^6$ .

If the key 21 for printing "A" on machine 20 is next depressed, contacts  $c^4, c^6$  will receive current from drum  $p^1$  through perforations  $f^4, f^6$ , so that magnets  $m^4, m^6$  will be energized and

close switches  $s^4$ ,  $s^5$  for energizing the magnet  $e^{12}$  to shift switch  $r^{12}$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , the right hand contact of switch  $s^4$ , conductor 42, the fourth contact from the left on switch  $s^5$ , switch  $u^{12}$ , electromagnet  $e^{12}$ , and conductor  $c^{10}$ . Switch  $r^{12}$  will then be closed to establish a circuit from conductor  $c^{11}$ , via the closed switch 29, a conductor 35, the twelfth pair of contacts from the left on switch  $r^{12}$ , a conductor 35<sup>a</sup>, and a contact  $k^4$  for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "W" on the machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that a perforation  $f^7$  will permit switch-contact  $c^7$  to receive current from the drum  $p^1$  and contacts  $c^4$  and  $c^5$  to receive current through perforations  $f^4$ ,  $f^5$ . The next depression of the same key 21 will cause the magnet  $e^{12}$  to be energized to shift switch  $r^{12}$  as before described and electromagnet  $m^7$  to receive current from contact  $c^7$  and hold the switch  $k$  in position to engage contacts  $k^3$ . Current will then flow via the twelfth pair of contacts from the left on switch  $r^{12}$ , a contact  $l^3$ , a switch  $l$ , a contact  $k^3$ , switch-member  $k^1$ , and energize that magnet 28 which is connected to the key-lever 27 for printing the letter "X" on machine 24. Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations  $f^5$ ,  $f^6$  to the contacts  $c^5$ ,  $c^6$ .

If the key 21 for printing "A" on machine 20 is next depressed, contacts  $c^5$ ,  $c^6$  will receive current from drum  $p^1$  through perforations  $f^5$ ,  $f^6$ , so that magnets  $m^5$ ,  $m^6$  will be energized and close switches  $s^5$ ,  $s^6$  for energizing the magnet  $e^7$  to shift switch  $r^{13}$  through the following circuit from the switch 29 which is closed by the depressed key: Conductor  $c^9$ , the right hand contact of switch  $s^5$ , conductor 42, the contact on the right of switch  $s^6$ , switch  $u^{13}$ , electromagnet  $e^{13}$ , and conductor  $c^{10}$ . Switch  $r^{13}$  will then be closed to establish a circuit from conductor  $c^{11}$ , via the closed switch 29, a conductor 35, the thirteenth pair of contacts from the left of contact-switch  $r^{13}$ , a conductor 35<sup>a</sup>, a contact  $k^4$ , for energizing that magnet 28 which is connected to shift the key-lever 27 for printing the letter "Y" on the machine 24. The tape  $f$  is next advanced one step when the depressed key 21 is released, so that a perforation  $f^7$  will permit switch-contact  $c^7$  to receive current from the drum  $p^1$  to energize magnet  $m^7$  and contacts  $c^5$  and  $c^6$  to receive current through perforations  $f^5$ ,  $f^6$ . The next depression of the same key 21 will cause the magnet  $e^{13}$  to be energized to shift switch  $r^{13}$  as before described and electromagnet  $m^7$  to receive current from contact  $c^7$  to hold the switch  $k$  in position to engage contacts  $k^3$ . Current will then flow via the thirteenth pair of contacts from the left on switch  $r^{13}$ , a contact  $l^3$ , a switch-member  $l'$ , a contact  $k^3$ , a switch-member  $k^1$ , and energize that magnet 28 which is connected to shift the key-lever 27 for printing the letter "Z" on machine 24. Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations in the tape to the contacts associated with the drum  $p^1$ . Upon release of said key-lever 21 the tape  $f$  will be again advanced one step and will bring the next transversely aligned perforations in the tape to the contacts associated with the drum  $p^1$ .

The alternate contacts  $k^4$  are directly connected to conductors 35<sup>a</sup>, 35<sup>b</sup> respectively for the flow of current from said conductors via contacts  $k^4$  and members  $k^1$  through the solenoids respectively, as selectively controlled by the switches  $r$ . When switch  $k$  is shifted to engage contacts  $k^3$ , the selection of the solenoids 28 will be varied by current which may flow from each of said conductors via a contact  $l^4$ , member  $l'$ , a contact  $k^3$ , and switch-member  $k^1$  to the next solenoid 28 to the left. This change occurs during the typing of the text of a message on machine 20 and a cryptogram on machine 24.

The invention provides for typing on the machine 24 a translation of the cryptogram when it is typed on the machine 20, and utilizes the same or a like perforated tape  $f$  with like code-elements or arrangement of the perforations for automatically printing the translation when the machine 20 is operated by including the switches of the group  $u$  for varying the selection of the magnets by the same permutations of the switches of the  $s$  group, and the switch  $l$  and its associated connections for changing the selection of the solenoids 28.

When translating the cryptogram being typed on machine 20 to the original text on machine 24, the group of switches  $u$  will be shifted to vary the selection of the switches of the group  $r$  by the tape controlled mechanism for selection of the solenoids 28 for said translation and the switch  $l$  will be manually shifted to the left so that members  $l'$  will engage contacts  $l^3$ . When switch  $k$  is in its normal position and engaged with contacts  $k^4$  the solenoids will be selectively controlled by the change in the selective closing of the switches of the group  $r$  as they are controlled by the switches  $u$ . When the switch  $k$  is shifted to the left under control of the perforations  $f^7$  in the tape  $f$  while switch  $l$  is shifted to the left, members  $k^1$  will engage contacts  $k^3$  and be disengaged from contacts  $k^4$ . Current may then flow from conductors 35<sup>a</sup>, 35<sup>b</sup> via contacts  $l^3$ , members  $l'$ , contacts  $k^3$  and members  $k^1$  to the solenoids at the right of those to which the conductors are connected through contacts  $k^4$ . This changes the selection of the solenoids 28 under control of the switches  $r$  and  $u$  for typing the translation of the cryptogram on machine 24 and machine 24 is used for typing. The switch  $r^1$ , which is closed by magnet  $l'$  when a pair of perforations  $f^2$ ,  $f^3$  are at the operative station, causes switches  $s^2$ ,  $s^3$  to be closed, control connections to the solenoids 28 for typing the same letter on machine 24 which is typed on machine 20, and for that reason no translation is necessary for the selection of the solenoids 28 when the cryptogram is being typed on machine 20 for translation to the original message on machine 24.

An exemplification of the operation of the machine will be as follows: Assuming the message is "Grace" and the code used is that represented on the tape  $f$ , the latter will be initially placed on the drum  $p^1$  so that contacts  $c^2$ ,  $c^3$  will, through perforations  $f^2$ ,  $f^3$ , engage the drum. The operator will then depress the key for typing the letter "G" on machine 20, which will simultaneously close the switches 29 and 30 associated with the same key. Switch 30 will close the circuits for energizing magnets  $m^2$ ,  $m^3$  to close switches  $s^2$ ,  $s^3$  for selectively energizing magnet  $e^1$  to close switch  $r^1$ . Switch  $r^1$  will close a circuit for current to flow from the closed switch 29, via the conductor 35 which is connected to said

switch 29, the fourth pair of contacts from the left of the section of the switch  $r^1$  to which said switch 29 is connected, a conductor 35<sup>a</sup>, a contact  $k^4$ , a switch-member  $k^1$ , to energize the magnet 28 to cause the letter "G" to be typed on machine 24. Upon release of the manually depressed key the tape will be advanced one step to cause contacts  $c^2$ ,  $c^3$  and  $c^7$  through transversely aligned perforations  $f^2$ ,  $f^3$  and  $f^7$  to engage the drum.

Next the operator will depress the key for typing the letter "R" on machine 20 which will close the switches 29, 30 associated with said key. Switch 29 will close the circuits for energizing magnets  $m^2$ ,  $m^3$  to close switches  $s^2$ ,  $s^3$  and for energizing the magnet  $m^7$  to shift switch  $k$  to the left to engage contacts  $k^3$ . Current will then flow from the closed switch 29, via the conductor 35 connected to said switch 29, the fifth pair of contacts from the right of the section of the switch  $r^1$  to which said conductor 35 is connected, a conductor 35<sup>b</sup>, a conductor  $l^5$ , a contact  $l^3$ , a switch-member  $l^1$ , a contact  $k^3$ , and a switch-member  $k^1$ , to energize the magnet 28 for typing "S" on the machine 24. Upon release of the manually depressed key, the tape  $f$  will be advanced so that contacts  $c^1$ ,  $c^4$ , through a pair of transversely aligned perforations  $f^1$ ,  $f^4$ , will engage the drum  $p^1$ .

Next the operator will depress the key for the letter "A" on machine 20 which will close switches 29, 30 associated with said key. Contacts  $c^1$ ,  $c^4$  will close circuits to energize magnets  $m^1$ ,  $m^4$  for closing switches  $s^1$ ,  $s^4$  for selectively energizing the magnet  $e^2$  to close switch  $r^2$ . Current will then flow from the closed switch 29, via the conductor 35 connected to said switch 29, the second pair of contacts from the left of the section of switch  $r^2$  to which the closed switch 29 is connected, a conductor 35<sup>a</sup>, a contact  $k^4$ , and switch-member  $k^1$  to selectively energize the magnet 28 for typing the letter "C" on machine 24. When the manually depressed key is released the tape  $f$  will be advanced one step and contacts  $c^1$ ,  $c^4$  and  $c^7$  will, through transversely aligned perforations  $f^1$ ,  $f^4$  and  $f^7$ , engage drum  $p^1$ .

The operator will next depress the key for typing the letter "C" on machine 20 and close the associated switches 29 and 30. Magnets  $m^1$ ,  $m^4$  will be energized to shift associated switches  $s^1$ ,  $s^4$  to selectively energize the magnet  $e^2$  and close the switch  $r^2$ . The contact  $c^7$  will close the circuit for energizing the magnet  $m^7$  which will shift the switch  $k$  to the left to engage the contacts  $k^3$ . Current will then flow from the conductor 35 connected to said closed switch 29, via the third pair of contacts from the left of the section of switch  $r^2$  to which said switch 29 is connected, a conductor 35<sup>a</sup>, a conductor  $l^5$ , a contact  $l^3$ , a switch-member  $l^1$ , a contact  $k^3$ , a switch-member  $k^1$ , to energize the magnet 28 for typing the letter "R" on machine 24. When the manually depressed key is released the tape will be advanced one step so that contacts  $c^2$ ,  $c^4$  will, through a pair of transversely aligned perforations  $f^2$ ,  $f^4$ , engage drum  $p^1$ .

The operator will next depress the key for typing the letter "E" on machine 20 which will close the switches 29, 30 associated with said key. Said switch 30 will close circuits for operating magnets  $m^2$ ,  $m^4$  for closing switches  $s^2$ ,  $s^4$  to close the circuit for energizing the magnet  $e^3$  which will close the switch  $r^3$ . Current will then flow from the conductor 35 connected to the closed switch 29, via the fifth pair of contacts from the left of

the section of switch  $r^3$  to which said closed switch 29 is connected, a conductor 35<sup>a</sup>, a contact  $k^4$ , a switch-member  $k^1$ , to energize the magnet 28 for typing the letter "T" on machine 20. The typing of the message on machine 20 will produce the cryptogram "Gscfi" on machine 24.

When the equipment is used for printing the original message on machine 24 by typing the cryptogram on machine 20, the switch  $u$  will be shifted to the right to change the selection of the magnets of the  $e$ -series resulting from the perforations in the tape  $f$  and the switch  $l$  is shifted to the left to change the connections between the conductors 35<sup>a</sup> and 35<sup>b</sup> and the magnets 28 at the contacts  $l^3$  for switch-members  $l^1$ . The equipment will then function to print on the machine 20 the text of the original message when the cryptogram is typed on the machine 20.

Assuming the cryptogram to be that produced in the operation last described, the tape  $f$  will be set to bring the code perforations to the drum contacts in the same order in which they were used in typing the cryptogram. The operator will depress the key for typing the letter "G" on machine 20 and close the switches 29, 30 associated with said key. Contacts  $c^2$ ,  $c^3$  will, through perforations  $f^2$ ,  $f^3$ , engage drum  $p^1$  and establish circuits for magnets  $m^2$ ,  $m^3$  to close switches  $s^2$ ,  $s^3$  for selectively energizing the magnet  $e^1$  and closing switch  $r^1$ . Current will then flow from the conductor 35 connected to said closed switch 29, via the fourth pair of contacts from the left of the section of the switch  $r^1$  to which said closed switch 29 is connected, a conductor 35<sup>a</sup>, a contact  $k^4$ , switch-member  $k^1$ , and energize the magnet 28 for typing the letter "G" on machine 24. The tape  $f$  will be advanced one step when the manually depressed key is released to position transversely aligned perforations  $f^2$ ,  $f^3$  and  $f^7$  so that contacts  $c^2$ ,  $c^3$  and  $c^7$  will engage drum  $p^1$ .

The key for typing the letter "S" on machine 20 will then be depressed and close the associated switches 29 and 30. Magnets  $m^2$ ,  $m^3$  will be energized and shift switch  $k$  to the left. Switch  $s^2$ ,  $s^3$  will close the circuit for energizing magnet  $e^1$  which will close switch  $r^1$ . Current will then flow from the conductor 35 which is connected to the closed switch 29, via the fourth pair of contacts from the right of the series of the switch  $r^1$  to which said closed switch 29 is connected, a conductor 35<sup>b</sup>, a contact  $l^5$ , a switch-member  $l^1$ , a contact  $k^3$ , and a switch-member  $k^1$ , to energize the magnet 28 for typing the letter "R" on machine 24. The tape  $f$  will be advanced one step when the manually depressed key is released so that contacts  $c^1$ ,  $c^4$  and  $c^7$  will, through a pair of transversely aligned perforations  $f^1$ ,  $f^4$ , engage the drum  $p^1$ .

The key for printing the letter "C" on machine 20 will then be depressed which will close the switches 29, 30 associated with said key. Magnets  $m^1$ ,  $m^4$  will then be energized by current from contacts  $c^1$ ,  $c^4$  to close switches  $s^1$ ,  $s^4$  which will then establish a circuit via conductor  $c^9$ , switch  $s^1$ , conductor 40, the first contact to the left of switch  $s^4$ , switch-member  $u^2$ , conductor 44, to energize magnet  $e^{13}$  which will close switch  $r^{13}$ . Current will then flow from the conductor 35 connected to the closed switch 29, via the first pair of contacts from the left of the section of the switch  $r^{13}$  to which said closed switch 29 is connected, a conductor 35<sup>a</sup>, a conductor  $l^5$ , a switch-member  $l^1$ , and a switch-member  $k^1$ , to energize the magnet 28 for typing the letter "A" on machine 24. The tape  $f$  will be advanced one step when the man-

ually depressed key is released and contacts  $c^1$ ,  $c^4$  and  $c^7$  will, through transversely aligned perforations  $f^1$ ,  $f^4$  and  $f^7$ , engage the drum  $p^1$  to cause magnet  $e^{13}$  to be energized as last described. Contact  $f^7$  will close the circuit for energizing the magnet  $m^7$  to shift the switch  $k$  to the left to engage contacts  $k^3$ .

The key for typing the letter "F" on machine 20 is then depressed and closes the switches 29 and 30 associated with said key. Switch 30 will close the circuit for energizing magnets  $m^1$ ,  $m^4$  and  $m^7$  and shift the switches  $s^1$  and  $s^4$  and magnet  $e^{13}$  will be energized so that switch  $r^{13}$  will be closed. Current will flow from the conductor 35 which is connected to the closed switch 29, via the second pair of contacts to the left of the section of the switch  $r^{13}$  to which the closed switch 29 is connected, a conductor 35<sup>a</sup>, a contact  $P$ , a switch-member  $I'$ , a contact  $K^3$ , and a switch-member  $K^1$ , to energize the magnet 28 for typing the letter "C" on machine 24. The tape will be advanced one step when the manually depressed key is released and contacts  $c^2$ ,  $c^4$  will, through a pair of transversely aligned perforations  $f^2$ ,  $f^4$ , engage the drum  $p^1$ .

The operator then depresses the key for typing the letter "I" on machine 20 and closes switches 29, 30 associated with said key. The closed switch 30 will close the circuits for energizing magnets  $m^2$  and  $m^4$  to close switches  $s^2$ ,  $s^4$  which will establish a circuit via a conductor 35, a switch  $s^1$ , a conductor 40, the left hand contact of switch  $s^4$ , a switch-member  $u^3$ , and a conductor 45, to energize the magnet  $e^{12}$  which will close the switch  $r^{12}$ . Current will then flow from the conductor 35 connected to the closed switch 29, via the third pair of contacts from the left of the section of switch  $r^{12}$ , to which said switch 29 is connected, a conductor 35<sup>a</sup>, a contact  $P$ , a switch member  $I'$ , a contact  $K^2$ , and a switch-member  $K^1$ , to energize the magnet 28 for typing the letter "E" on machine 24. The original message "Grace" will then be typed on machine 24.

The invention exemplifies cryptographic equipment for use with two typewriting machines, comprising mechanism automatically and selectively controlled by a code or a record or code elements on a tape for controlling the typing of a cryptogram on one machine while the plain text of the original message is typed on the other. The invention also exemplifies equipment which may be used for automatically translating a cryptogram while it is being typed on one machine, through code controlled mechanism, to a typed message in its original text on the other machine. The invention also exemplifies automatic and selective control mechanism for these purposes which is controlled by a code on a tape or a record which affects the translations automatically without mental effort. The invention also exemplifies control mechanism for these purposes in which the same or a like perforated tape may be used for automatically coding and typing a printed message and decoding and typing it. The invention also exemplifies cryptographic equipment which can be operated substantially at the same speed with which typewriting machines are ordinarily operated and by which errors in translation will be avoided.

The invention is not to be understood as restricted to the details herein set forth, since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described the invention, what I

claim as new and desire to secure by Letters Patent is:

1. In equipment of the character described, the combination with a typewriting machine equipped with manually controlled type-bars for printing a set of characters, and a second machine equipped with a set of electromagnetically controlled type-bars for printing a like set of characters, of a record provided with code-elements for coding the characters printed on the machine with manually controlled type-bars and mechanism and connections, controlled by said code elements, for automatically and selectively controlling the simultaneous printing of a translation on the second machine of the characters printed by the manually controlled type-bars, said mechanism comprising switch means for alternately selecting, for operation, one-half of the electromagnetically operated type-bars, and means, controlled by the code-elements, for automatically shifting said switch means.

2. In equipment of the character described, the combination with a typewriting machine equipped with manually controlled type-bars for printing a set of characters, and a second machine equipped with a set of type-bars for printing a like set of characters and electromagnetic devices for controlling the operation of said last named bars, of a tape provided with perforations forming a code for coding the characters printed on the machine with manually controlled type-bars and mechanisms and connections, controlled by said perforations, for automatically and selectively controlling the simultaneous printing of a translation on the second machine of the characters printed by the manually controlled type-bars, said mechanism comprising switch means for alternately selecting one-half of the electromagnetic devices, and means controlled by the perforations in the tape for automatically shifting said switch means.

3. In equipment of the character described, the combination with a typewriting machine equipped with type-bars for printing a set of characters and keys for manually controlling said type-bars, and a second typewriting machine equipped with a set of type-bars for printing a like set of characters, and electromagnets for controlling the printing by the last named type-bars, of a tape provided with perforations arranged according to a code for coding the characters printed on the machine with manually controlled type-bars, mechanism controlled by the perforations for controlling the printing of a translation of the characters printed by the operation of the keys, said mechanism comprising a series of switches for connecting the manually controlled keys and the electromagnetic devices, and a series of switches permutably controlled by the perforations in the tape, for selectively controlling the connection-switches.

4. In equipment of the character described, the combination with a typewriting machine equipped with type-bars for printing a set of characters and keys for manually controlling said type-bars, and a second typewriting machine equipped with a set of type-bars for printing a like set of characters, and electromagnets for controlling the printing by the last named type-bars, of a tape provided with perforations arranged according to a code for coding the characters printed on the machine with manually controlled type-bars, mechanism controlled by the perforations for controlling the printing of a translation of the characters printed by the

operation of the keys, said mechanism comprising a series of switches for connecting the manually controlled keys and the electromagnetic devices, a series of switches permutably controlled by the perforations in the tape for selectively controlling the connection-switches, and switch-means between the permutably controlled switches and the connection-switches for varying the selection of the connection-switches by the permutably controlled switches.

5. In equipment of the character described, the combination with a typewriting machine equipped with type-bars for printing a set of characters and keys for manually controlling said type-bars, and a second typewriting machine equipped with a set of type-bars for printing a like set of characters, and electromagnets for controlling the printing by the last named type-bars, of a tape provided with perforations arranged according to a code for coding the characters printed on the machine with manually controlled type-bars, mechanism controlled by the perforations for controlling the printing of a translation of the characters printed by the operation of the keys, comprising a series of permutably operable switches controlled by the keys for supplying current to the electromagnets, a series of switches for controlling said connections and selectively controlled by the permutably controlled switches, switch means in said connections for alternately selecting groups of the electromagnets, and means controlled by the tape for controlling said last named switch means.

6. In equipment of the character described, the combination with a typewriting machine equipped with type-bars for printing a set of characters and keys for manually controlling said type-bars, and a second typewriting machine equipped with a set of type-bars for printing a like set of characters, and electromagnets for controlling the printing by the last named type-bars, of a tape provided with perforations arranged according to a code for coding the characters printed on the machine with manually

controlled type-bars, mechanism controlled by the perforations for controlling the printing of a translation of the characters printed by the operation of the keys, comprising a series of connections controlled by the keys for controlling current to the electromagnets, a series of switches for selectively controlling said connections, said connections also including switch means for alternately selecting groups of the electromagnets, means controlled by the tape for controlling said last named switch means, and manually operable switch means between the connections for varying the connections to the electromagnets.

7. In equipment of the character described, the combination with a typewriting machine equipped with type-bars for printing a set of characters and keys for manually controlling said type-bars, and a second typewriting machine equipped with a set of type-bars for printing a like set of characters, and electromagnets for controlling the printing by the last named type-bars, of a tape provided with perforations arranged according to a code for coding the characters printed on the machine with manually controlled type-bars, mechanism controlled by the perforations for controlling the printing of a translation of the characters printed by the operation of the keys, comprising a series of permutably operable switches controlled by the perforations in the tape, connections controlled by the keys for controlling current to the electromagnets, a series of switches in said connections, selectively controlled by the permutably controlled switches, said connections also including switch means for alternately selecting groups of the electromagnets, means controlled by the tape for controlling said last named switch means, manually operable switch means between the permutably operable switches and the switches in said connection for varying the selection of switches in said connections, and manually controlled switch-means in the connections for varying the selection of the electromagnets.

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