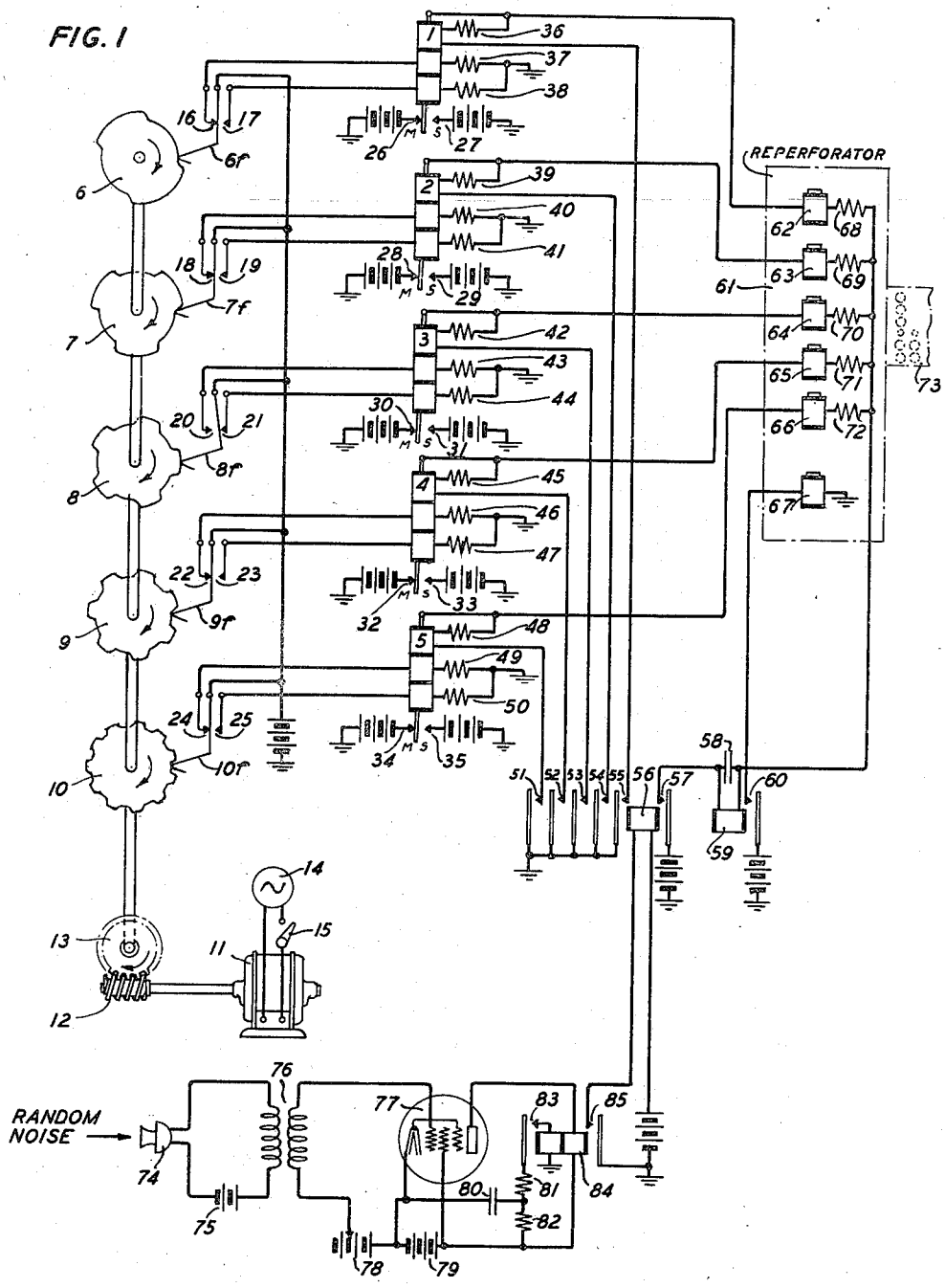
Aug. 20, 1946. T. A. McCANN 2,406,024

KEY TAPE DEVICE FOR ENCIPHERING TELEGRAPH SIGNALS

Filed May 28, 1942 2 Sheets-Sheet 1

FIG. 1



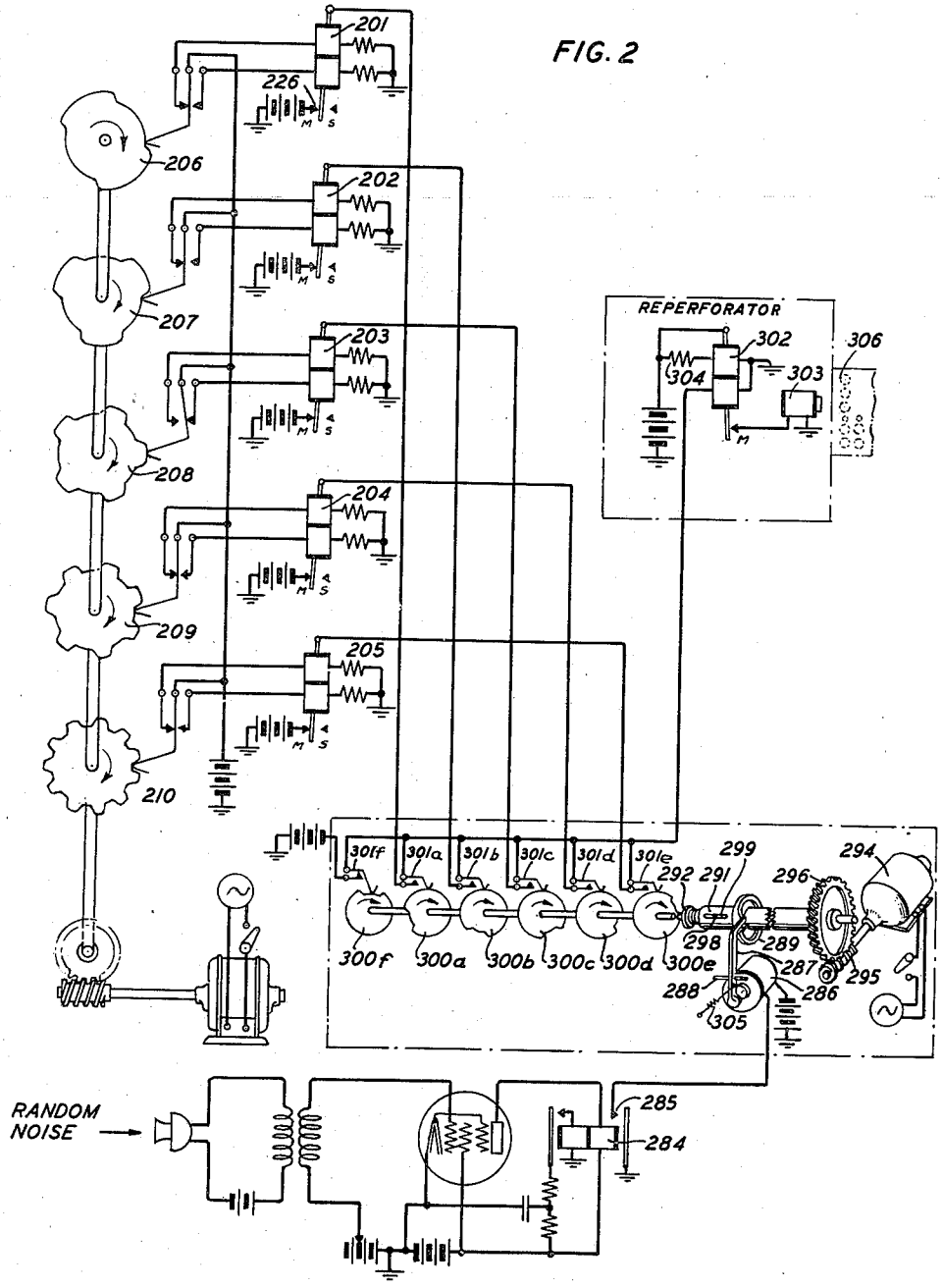
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FIG. 2



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KEY TAPE DEVICE FOR ENCIPHERING TELEGRAPH SIGNALS

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This invention relates to telegraph signal enciphering systems and more particularly to a device for preparing key tape by means of a completely automatic mechanism in random fashion for use in enciphering and deciphering Baudot code telegraph signals.

A certain system well known in the art for enciphering and deciphering Baudot code telegraph signals makes use of what is known as a "key tape." In operating this system, the signals as transmitted between stations are the resultants of the unenciphered code for a particular symbol modified by the signal elements of the key tape. The key tape is prepared in advance. One is used at the transmitting station for enciphering the signals and an identical tape is used at the receiving station for deciphering the signals. The tapes at each station are operated in synchronism.

In order to guard against deciphering of the signals which might be intercepted in transmission between stations, it is desirable that the enciphering key tape have a very large number of punched characters so that the enciphering pattern is not frequently repeated. In operating this system on occasions, two tapes are used at each station. One tape, for instance, may have 1000 characters and the second tape may have 999 characters. The two tapes at each station are operated in synchronism. By using this arrangement, it is possible to transmit 999,000 characters before the enciphering pattern is repeated. As the number of stations is increased and as the volume of messages transmitted over teletypewriter circuits is increased the possibilities of detection are increased. The number of tapes required is very large. The preparation of tape by hand is particularly arduous and has been found to be not sufficiently random.

In the present invention a set of cams designed to provide all of the character combination of a five-digit Baudot code are combined with an amplifier operated by random noise to control a group of five polar relays. The relays in turn control the punch setting magnets of a perforator. The perforator punching magnet is operated under control of the noise amplifier. The arrangement is completely mechanical and the combination of the two different controls, namely, the cam control and the random noise amplifier control provides a full mechanical device which is completely random in operation.

It is an object of this invention to provide a completely automatic device for punching a key tape in a random manner.

The invention may be understood from the following description when read with reference to the accompanying drawings in which:

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Fig. 1 shows a tape punching device in which the tape punching elements are selected by a group of five polar relays provided with dual controls, one control being a set of cams and the other control a random noise operated amplifier; and

Fig. 2 is another embodiment of the invention in which the arrangement in Fig. 1 is modified to cooperate with a different tape perforator.

The two bottom windings of relays 1 to 5 are under control of cams 6 to 10. The cams are driven by motor 11 through worm 12 and gear 13. When power source 14 is connected to motor 11 by closing switch 15 worm 12 revolves driving gear 13 in a clockwise direction. Cams 6 to 10 and gear 13 are locked to the same shaft so that cams 6 to 10 rotate clockwise as gear 13 rotates. Spring followers 6f to 10f engage with cams 6 to 10, respectively. The spring followers are tensioned so as to engage their respective cams along the entire periphery of each cam. When the follower engages the depressed portion of the periphery of a cam, the follower is actuated to the left to engage its respective left-hand contact. When the follower engages a raised surface on the periphery of a cam, the follower is actuated to the right to engage its right-hand contact. Thus, followers 6f, 7b, 9f and 10f are shown in engagement with depressed surfaces on the peripheries of their respective cams and are consequently actuated to the left to engage contacts 16, 18, 22 and 24. Follower 8f engages a raised surface on the periphery of cam 8 and is, therefore, actuated to the right to close contact 21.

Cams 6, 7, 8, 9 and 10 have 2, 3, 5, 7 and 11 raised and depressed surfaces on their peripheries, respectively. The relative lengths of the raised and depressed surfaces of each of the cams is such that the follower of each cam engages each of its two cooperating contacts for equal intervals on each reversal. All of the combinations of the Baudot teletypewriter code will be set up on the contacts of the five relays in the course of rapidly repeating intervals.

Each of relays 1 to 5 has three windings. When the circuit through the bottom winding of any of these relays is closed the armature of the relay is actuated to the right to engage its spacing contact. When the circuit through the middle winding of a relay is closed the armature is actuated to the left to engage its marking contact. When the circuit through the top winding of any of these relays is closed the armature of the particular relay is locked in the position which it

occupies at the instant when the circuit through its top winding is closed.

A circuit may be traced from battery through contact 16, middle winding of relay 1 and resistance 37 to ground actuating the armature of relay 1 to the left to engage its marking contact 26. A circuit may be traced from battery through contact 18, middle winding of relay 2 and resistance 40 to ground actuating the armature of relay 2 to engage with its left-hand or marking contact 28. A circuit may be traced from battery through contact 21, bottom winding of relay 3 and resistance 31 to ground operating the armature of relay 3 to engage with its right-hand or spacing contact 31. A circuit may be traced from battery through contact 22, middle winding of relay 4 and resistance 46 to ground operating the armature of relay 4 to engage with its left-hand or marking contact 32. A circuit may be traced from battery through contact 24, middle winding of relay 5 and resistance 49 to ground operating the armature of relay 34 to engage with its left-hand or marking contact 34. The cams are rotated continuously. The armatures of relays 1 to 5 are actuated to the left and right between their respective marking and spacing contact depending upon which of their windings is energized.

At intervals, the armatures of relays 1 to 5 will be locked momentarily in the positions which they have assumed at the instant. The manner in which this is performed is now to be described.

A carbon microphone 74 may be used to pick up random noise from any suitable source. In this case the frying of the carbon granules of the microphone results in a voltage pulse across the primary of transformer 76 which is induced in the secondary. The potential of the grid of vacuum tube 77 is normally negative with respect to its cathode due to battery 78. The amplifier may be provided with a threshold adjustment which will select the voltage peaks caused by the noise to which tube 77 will respond. When the tube becomes conducting a circuit is established from the positive terminal of battery 79 through the right-hand winding of relay 84 to the anode of tube 77, through the tube to the cathode and ground operating relay 84.

Relay 84 is provided with a holding circuit designed to hold the relay operated momentarily and then to release it automatically. The manner in which this functions will now be explained.

A circuit may be traced from the positive terminal of battery 79 through resistance 82 to the right-hand terminal of condenser 80. A circuit may also be traced from the negative terminal or battery 79 to the left-hand terminal of condenser 80. Condenser 80 is charged to the potential of battery 79 during the intervals while relay 84 is unoperated. When contact 83 closes, a circuit is established from the right-hand terminal of battery 79 through resistance 82, resistance 81, contact 83, and the left-hand winding of relay 84 to ground. The resistance in this path is too high to permit battery 79 alone to hold relay 84 operated. However, when contact 83 closes, condenser 80 discharges through resistance 81, contact 83 and the right-hand winding of relay 84 to ground. The capacity of condenser 80 and the impedance of its discharge path are chosen so that the condenser discharge current added to the regular steady battery current maintains relay 84 locked in the operated position for a predetermined interval. When the condenser 80 has discharged relay 84 releases. Relay 84 remains operated, however, long enough to permit the punching mechanism to function.

The closure of contact 85 during the interval while relay 84 is operated established a circuit from battery through the winding of relay 56 and contact 85 to ground operating relay 56. The operation of relay 56 closes contacts 51 to 55, inclusive, and contact 57. The closing of these contacts locks the armatures of relays 1 to 5 in whatever position they happen to be at the moment by closing the path through the top or locking winding of each of these relays.

The closing of contact 55 establishes a circuit from ground through the top winding of relay 1, resistance 36, armature of relay 1 and contact 26 to negative battery. The closing of contact 54 establishes a circuit from ground through contact 54, top winding of relay 2, resistance 39, armature of relay 2 and contact 28 to negative battery. The closing of contact 53 establishes a circuit from ground through contact 53, top winding of relay 3, resistance 42, armature of relay 3 and contact 31 to positive battery. The closing of contact 52 establishes a circuit from ground through contact 52, top winding of relay 4, resistance 45, armature of relay 4 and contact 32 to negative battery. The closing of contact 51 establishes a circuit from ground through contact 51, top winding of relay 5, resistance 48, armature of relay 5 and contact 34 to negative battery. Each of the armatures will, therefore, be locked in the indicated position as long as relay 56 is maintained operated.

When the armature of relay 1 is locked in engagement with its marking contact 26 and contact 57 is closed, a circuit may be traced from positive battery through contact 57, winding of relay 59, resistance 68, winding of punch setting magnet 62, armature of relay 1 and contact 26 to negative battery energizing the winding of punch setting magnet 62. The windings of punch setting magnets 63, 65 and 66 are also energized over corresponding circuits. In the case of punch setting magnet 64, since the armature of relay 3 is locked in engagement with its right-hand or spacing contact 31 both ends of the circuit extending through the winding of this particular magnet are terminated in positive battery so that no current will flow through the winding of punch setting magnet 64. The punches of magnets 62, 63, 65 and 66 will be set in the punching position as a result of the energization of their respective windings. The punch associated with punch setting magnet 64 will not be set in the punching position since the magnet is deenergized. Relay 59 does not operate for a short interval after relay 56 operates and contact 57 closes due to condenser 58 shunting its winding. Relay 59 is made slow to operate to delay the closing of contact 60 until after the punches of the perforator have been set. Upon the closure of contact 60 the winding of punching magnet 67 is energized. Punches which have been set by the punch setting magnets 62, 63, 65 and 66 will be actuated to perforate tape 73 in corresponding positions.

Upon the release of relay 84 contact 85 will open in turn releasing relay 56. Contacts 51 to 55 will open unlocking relays 1 to 5. Contact 57 will open releasing relay 59 in turn opening contact 60. The opening of contact 57 disconnects positive battery from the right-hand terminals of resistances 68 to 72, inclusive, associated with punch setting magnets 62 to 66, inclusive. Tape 73 will be moved forward one position in a

well-known manner and the cycle of operation will be repeated.

Fig. 2 shows another embodiment of this invention. It employs a cam transmitter distributor and a different reperforator both of well-known design in place of relays 56 and 59 together with their associated wiring and apparatus. The five relays 201 to 205, inclusive, and the five cams 206 to 210, inclusive, in Fig. 2 operate in the same manner as relays 1 to 5 and cams 6 to 10 in Fig. 1, with the difference, however, that the armatures of the relays are not locked in position. In the arrangement in Fig. 2 the locking circuit for each relay is omitted. The noise amplifier circuit in Fig. 2 operates in the same manner as in Fig. 1. When relay 284 in Fig. 2 which corresponds to relay 84 in Fig. 1 operates, contact 285 is closed energizing the winding of magnet 286 over an obvious circuit. The energization of magnet 286 rotates armature 287 around fixed pin 288. The upper inwardly-bent end of armature 287, which has been interposed in the path of cam 289 to prevent the rotation of the cam distributor shaft 290, is displaced. Sleeve 291 is driven to the right under the influence of spring 292 closing clutch 293. Motor 294 rotates worm 295, gear 296, driving shaft 297 and sleeve 291. The pin 298 in cam shaft 290 protrudes through the longitudinal sleeve sliding slot 299 in the sleeve 291. As the sleeve 291 rotates it in turn rotates shaft 290. Cams 300*a* to 300*f*, inclusive, are rigidly secured to shaft 290. As the shaft rotates, followers associated with each of the cams are actuated to open and close corresponding contacts 301*a* to 301*f*, inclusive, sequentially.

When shaft 290 is in the stop position, follower 301*f* is in engagement with the depressed segment of the periphery of cam 300*f*. A circuit may then be traced from negative battery through contact 301*f* and the bottom winding of relay 302 to ground. The effect of current flowing in this path tends to actuate the armature of relay 302 to the right to engage with its marking contact. This effect is opposed by the effect of current flowing from positive battery through resistance 304 and the top winding of relay 302 to ground which tends to actuate the armature of relay 302 toward the left. The effect of the current in the bottom winding is dominant, however, and the armature is maintained in engagement with its right-hand contact when shaft 290 is stopped in the normal stop position. When shaft 290 is rotated in a clockwise direction as indicated by the arrows on the cams, contact 301*f* is first opened disconnecting negative battery from the bottom winding of relay 302 as the follower associated with cam 300*f* engages the raised surface of the periphery of cam 300*f*. Then follower 301*a* drops into the depression on the periphery of cam 300*a*. If the armature of relay 201 is in engagement with its left-hand or marking contact, as shown, a circuit will be established from negative battery through contact 226, armature of relay 201, contact 301*a* and the bottom winding of relay 302. Since the polarity of the battery connected to the marking contact of relay 201 is the same as the polarity of the battery connected to contact 301*f* the armature of relay 302 will be maintained in its right-hand or marking position. If the armature of relay 201 is in its right-hand position the circuit through the bottom winding of relay 302 will be open and the armature of relay 302 will be actuated to the left under the influence of current in the top or biasing winding of relay 302.

As the cams continue to rotate the follower of each one in turn will drop into its respective recess. If the armature of the corresponding relay is at the moment connected to its left-hand or marking contact, negative battery will be connected to the left-hand terminal of the bottom winding of relay 302 and the armature of relay 302 will engage its marking contact. If the armature of the respective relay is in engagement with its right-hand or spacing contact the path through the bottom winding of relay 302 will be open. The armature of relay 302 will be actuated to the left under the influence of its biasing winding. Whenever the armature of relay 302 engages its marking contact the winding of selector magnet 303 will be energized over an obvious circuit. When the armature of relay 302 is actuated toward the left the winding of selector magnet 303 will be deenergized. The transverse positions in tape 306 will be punched or remain unpunched in a well-known manner depending upon the positions assumed by the armature of relay 302.

When relay 284 releases magnet 286 will be deenergized and its armature 287 will be restored to the stop position under the influence of spring 305. When the inwardly-bent end of armature 287 is again interposed in the path of cam 289 sleeve 291 will be actuated to the left by the raised surface of the right-hand cam face compressing spring 292 and opening clutch 293. When the clutch is opened the rotation of shaft 291 is stopped. Cam 289 is arranged so that when clutch 293 is disengaged shaft 290 is in position so that contact 301*f* is closed and relay 302 is in the marking condition. This is effected by the inwardly-bent end of armature 287 which engages a shoulder on the cooperating surface of cam 289 at the proper stop position. Contact 301*f* is closed in this position. The armature of relay 302 will be actuated to the right to engage its marking contact as heretofore explained. The apparatus is then in condition for the repetition of the cycle.

What is claimed is:

1. A device for punching a key tape for a ciphering system for permutation code telegraph signals comprising a tape punching mechanism having a first control comprising a cam operated contact and a second control comprising a random noise operated contact.

2. A device for punching a key tape for a ciphering system for permutation code telegraph signals comprising a tape punching mechanism, means for controlling said mechanism comprising a plurality of cam operated contacts, and a single amplifier arranged to respond to random noise also controlling said mechanism.

3. A device for punching a key tape for a ciphering system for permutation code telegraph signals comprising a tape punching mechanism, a magnet in said mechanism and a dual control for said magnet comprising a rotatable device and a random noise controlled device.

4. A device for punching a key tape for a ciphering system for permutation code telegraph signals comprising a tape punching mechanism, an electromagnet therein, a winding thereon, two terminals on said winding, a circuit extending from one of said terminals to a device controlled by a cam and a circuit extending from the other of said terminals to a device controlled by random noise.

5. A dual control for a telegraph signal ciphering device comprising (1) a cam mechanism in-

cluding control means for establishing all of the individual code combinations in a multielement permutation code and (2) an amplifier having an input circuit responsive to intermittent random noise and an output circuit controlling means for selecting the particular individual code combination established by said cams at the times of occurrence of said noise.

6. The method of preparing a key tape for use in enciphering multielement permutation code telegraph signals which comprises the following steps: (1) continuously operating a mechanism which arranges elements in accordance with each of the possible individual code combinations in the multielement permutation code for which the tape is being prepared at the same frequency in an ordered sequence, (2) in response automatically to the occurrence of intermittent, random, non-human physical phenomena, selecting and recording only the particular code combination established at the moment through the operation of step (1).

7. In a telegraph system, an enciphering device for enciphering permutation code telegraph signals comprising (1) mechanically operated cams, elements permutatively controlled by said cams to form patterns corresponding to each of the individual code combinations in a multielement permutation telegraph code successively in an ordered sequence and (2) an electromechanical device having a control responding automatically to a non-manual random event for selecting a particular pattern established by said elements upon the happening of said random event.

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