

CSGAS-76C

19 September 1949

**SUBJECT:** Patent Applications Nos. 107,244 and 682,096 of  
William F. Friedman Re Proposed Motion Control Means

**TO :** Chief, Projects Section

1. A brief summary is given herewith of Serial Nos. 107,244 and 682,096, two patent applications of William F. Friedman. The essential features of both inventions will be reviewed. Comments concerning them will be made with relation to the motion control means proposed by the undersigned, who desires to state, at this time, that he was unaware of the original plans, and that any coincidental resemblance between the two concepts is purely casual and not causal.

2. Serial No. 682,096 (filed 25 July 1933) provides a set of rotor stepping mechanisms, which may be controlled by one or more tape-transmitters of the usual type employed in Baudot systems of printing telegraphy. Several embodiments are illustrated, employing, respectively, one, two, and three tape-transmitters for controlling the individual electro-magnets which step the rotors of a cipher machine. The single tape-transmitter is of a well-known type but only one of the usual two bus bars is connected to current source in this case. The transmitter is operated by a cipher key tape bearing a series of perforations permuted in accordance with the Baudot code. These perforations control the action of five contact members, which in turn, through the circuit including power source and conductors, control the action of five electro-magnets, operable on a set of stepping pawls in a permutative

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manner. The cipher key tape is shown in the form of a continuous ring which can be started at different initial points. To permit an arrangement for obtaining a long secondary cipher key by the interaction of two relatively short primary keys, two interacting tape transmitters are shown in a second embodiment. Thus, two key tapes of 1000 and 999 characters would produce a resultant key of 990,000 characters. Each tape, passing through its own transmitter, affects a separate set of contact members, bringing them against one of two bus bars in a permutative manner. The circuits are such that only when two homologous contact members are in contact with opposite bus bars will current flow from power source through the magnet controlled by this pair of homologous contact members. Similarly, three or more tape-transmitters may be caused to interact for producing still longer resultant keys. The tape stepping magnets are controlled by a contact operated by the universal bar of the keyboard.

3. Serial No. 107,244 (filed 23 October 1936) is an improvement on the subject-matter of the foregoing application. The use of a cipher key tape and its tape-transmitter is eliminated, and, instead, there is shown an associated set of cam wheels of different diameters for controlling the stepping of the cipher rotors. Two embodiments are illustrated: the first employs five cam wheels to replace the single tape-transmitter, while the second example uses ten cam wheels which can be electrically combined into five pairs for controlling the wired rotors. The latter version is schematically shown in the accompanying diagram (copied from the patent application). Each of the ten contact levers

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is associated with two contacts: a lower contact against which it normally rests and an upper contact which it touches when a button on the associated cam wheel is presented to the contact lever. The switchboard serves as a means for interconnecting the contact levers in pairs so that the five rotor stepping magnets may be controlled, in effect by the five pairs of cam wheels. An irregular pattern of buttons on each cam wheel provides the cipher key which will determine the placement of a contact lever against its lower or upper contact. Each rotor stepping magnet will therefore be subject to four conditions:

If either of the two contact levers (of a pair) is pressing against a lower contact while the other contact lever is pressing against an upper contact (due to the influence of a button on the related cam wheel) then a circuit will be established through the electro-magnet and the pertinent cipher rotor will step.

If both contact levers (of a pair) are simultaneously pressing against lower contacts, or against upper contacts, then no circuit will be established through the electro-magnets because both levers are connected to the same side of battery.

A circuit is included so that on the backstroke of the universal bar on the keyboard, a contact is closed and stepping pawls are caused to advance the cam wheels one step, thereby setting up a new combination of operative and inoperative contact levers. The universal keyboard contact circuit also includes a relay which closes the circuit containing the

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cipher rotor stepping magnets so that current can pass through the latter magnets only at the instant when the universal contact is closed.

4. The principal feature of the preceding invention is the use of ten prime-sized cam wheels, operating in pairs through a switchboard, to close circuits through a group of stepping magnets which will advance the individual cipher rotors in a permutative manner. In the proposed motion control scheme, the effect on the cipher rotors, up to this point, is the same, with the following difference in the manner of accomplishment: the motion control unit of the patent application employs ten regularly-stepping carriers for the selected patterns of buttons or cam surfaces, whereas in the proposed plan there are five regularly-stepping carriers (the variable pin rotors) and five irregularly-stepping carriers (the cipher rotors which bear the notch rings). From the cryptanalytic viewpoint, there are, then, ten regularly-stepping wheels with unknown patterns as opposed to five regularly-stepping wheels with unknown patterns and five irregularly-stepping wheels with known patterns. (Presumably the notch rings are known to the enemy, although the use of a notch ring with variable pattern, similar to the Lueckenfueller of Enigma origin, would circumvent this condition.) What effect a dilated wheel with known pattern would produce in the over-all cryptanalytic picture would require further study. With both motion control schemes using five cipher rotors, the effect of the patent application method as contrasted with the undersigned's proposal is identical at this stage: any one of the 32 Baudot code permutations is possible at a given setting, resulting in the stepping of 0, 1, 2, 3, 4, or 5 rotors. The

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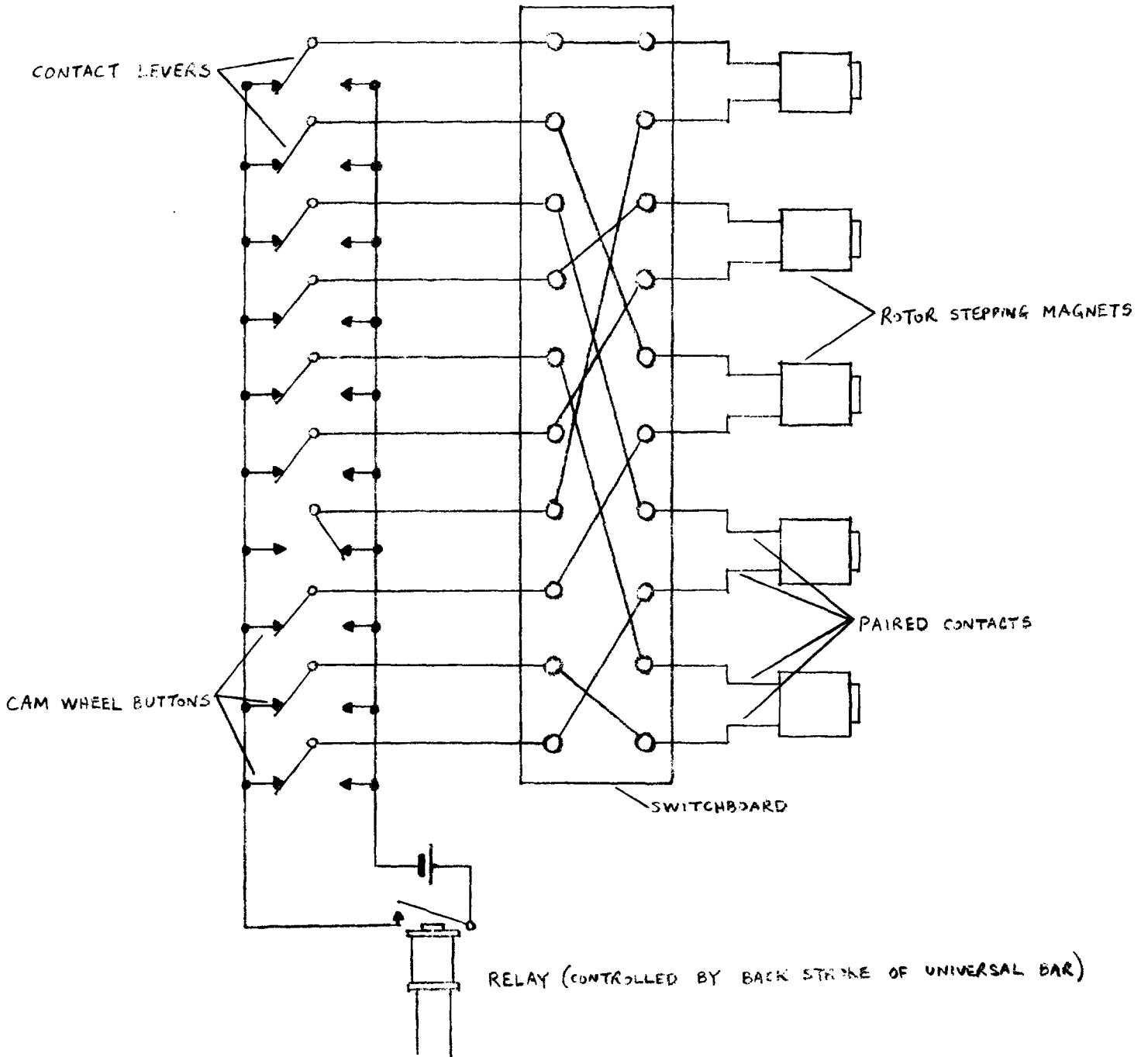
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proposed motion control plan, however, adds a further complexity by taking the output of the five rotor stepping circuits and leading these impulses through a sensing mechanism so that only a specific number of desirable stepping patterns are utilized. This additional mechanism consists of a Christmas tree circuit and a small compact unit comprising a switchboard matrix of 42 rectifiers, enabling a variable choice to be made from among, for example, 14 stepping patterns. The proposed stepping means become, therefore, readily realizable by the addition of a relay translator and in the light of the circuitry observed in the second patent application.

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MOTION CONTROL UNIT

(Copied from patent application serial no. 107,244 - W. F. Friedman)

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