ELECTRONIC CADENCE CONTROL FOR AUTOMATIC FIREARMS

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Fig. 1

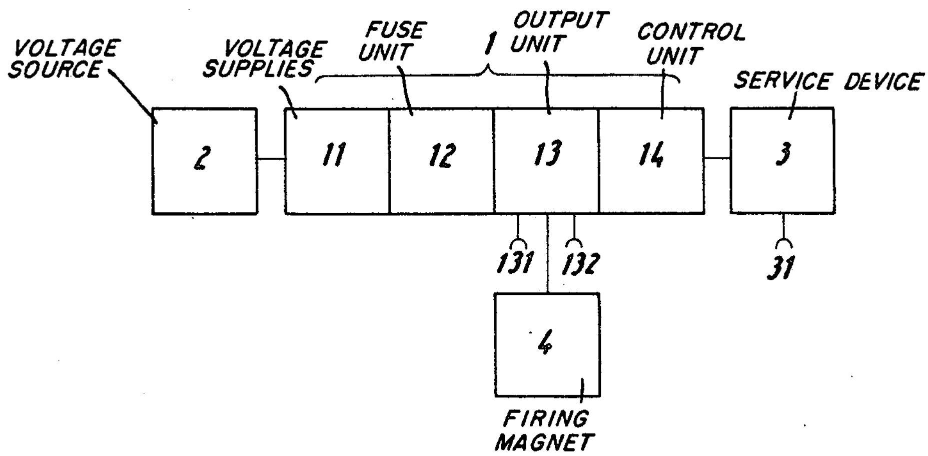

Fig. 2

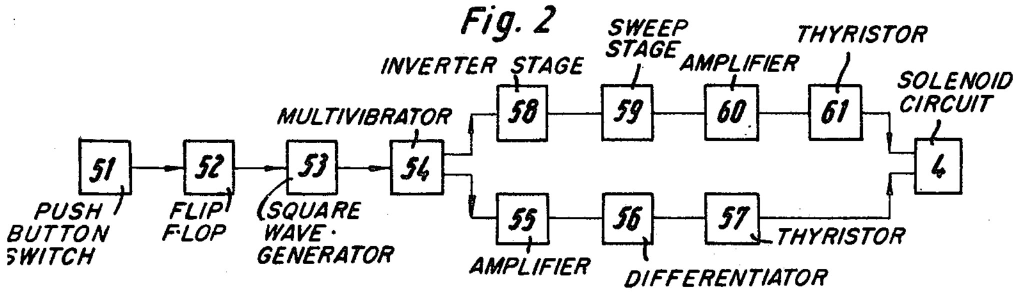

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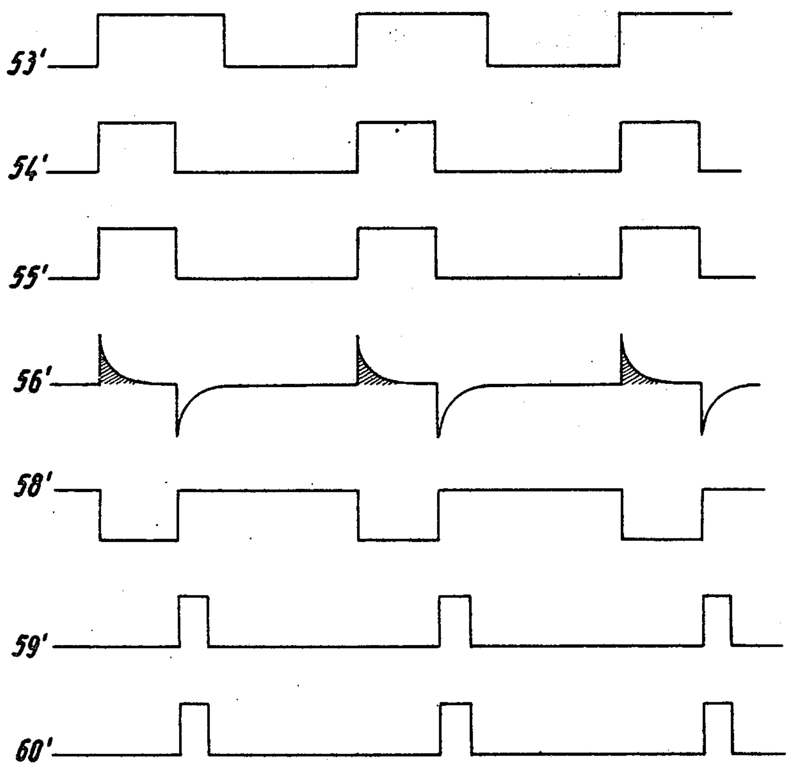
Fig. 4



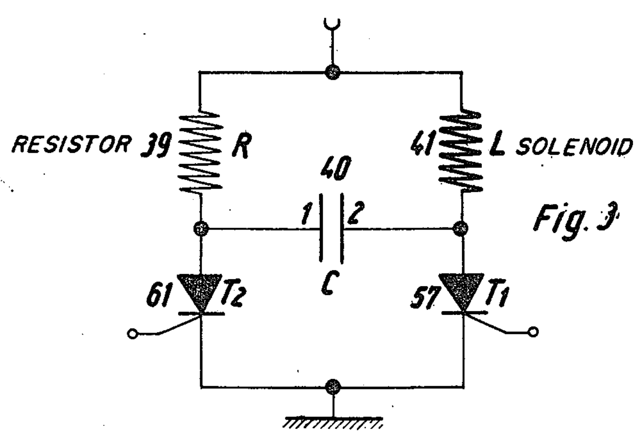


Fig. 3

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ELECTRONIC CADENCE CONTROL FOR AUTOMATIC FIREARMS

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U.S. Cl. 89—135 8 Claims

ABSTRACT OF THE DISCLOSURE

An electronic cadence controller for "controlled individual shots" from automatic fire arms, the firing of which is performed by operation of an electromagnet which comprises a square wave generator and a flip-flop. The settable pulse repetition rate of the square wave generator is equal to the desired cadence and its pulses are transformed into pulses of frequency-independent and constant duration, respectively, so that the pulses obtained from the ascending branches of the pulses lead to a switching on of the electromagnet and the pulses obtained from the descending branches of the pulses lead to a switching off of the electromagnet.

The present invention relates to an electronic cadence control for "controlled firing" of automatic fire arms, the firing of which takes place by means of an electromagnet, as well as to an electronic cadence control device. The control designed in accordance with the present invention is particularly adapted for automatic guns.

It is conventional in automatic guns, to provide for individual shots, in addition to the permanent firing, in which the shot succession and the cadence, respectively, is determined by the time period for the stroke and the return stroke of the breech, whereby also always only one shot is released. In addition, it is, however, desirable, to operate the fire arm in continuous firing, however, with reduced cadence, as set by the above-stated limit. In other words, single firing should be possible at predetermined timely distances between the individual shots. The breech block must thereby remain after each single firing for a set or even better settable time in the holding position, until the next shot is released. This type of operation is called "controlled single firing."

It has been attempted already to realize the required succession control by electro-mechanical means. In this arrangement, an electromotor rotates with set or a variable number of revolutions over a circular path with a predetermined number of individual contacts, whereby each contact connection releases a shot.

Different drawbacks are inherent in this solution. In addition to the volume requirement and the output requirement an appreciable wear in the operation must be taken in stride, which reduces the reliability of the control and whereby simultaneously the life of the device is limited. The high output requires often cooling devices, whereby the apparatus is also sensitive to temperature and atmospheric conditions. Furthermore, if no particular measures are taken, the device is dependent upon the line voltage of the power supply, which can vary only within limited ranges. Finally, a main drawback evists also in the extensive starting retardation, caused by the great masses of mechanically moved parts.

It is one object of the present invention to provide an electronic cadence control for automatic fire arms which avoids the drawbacks of the known structures.

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It is another object of the present invention to provide an electronic cadence control for automatic fire arms, wherein by the use of contactless structural elements the wear is removed, and whereby also the reliability and life is increased. By pouring, for instance, with silicon elastic gum, the shock and blow sensitivity is reduced. By suitable election of the structural elements, furthermore, the sensitivity against variations in the tension and temperature can be removed to a great extent and the retardation time can be chosen neglectibly small, compared with the time required for one shot. By the arrangement of a cadence controlled device in accordance with the present invention with exchangeable structural groups, occurring errors can easily be repaired (building blocks principle).

It is still another object of the present invention to provide an electronic cadence control for "controlled single shots" of automatic fire arms, the firing of which takes place by operation of an electro-magnet, which includes a square wave generator, the adjustable pulse repetition rate of which is equal to the desired cadence and the impulses of which are transformed by means of a monostable multivibrator into pulses of a frequency-independent and constant duration, respectively, so that the pulses obtained from the rise slope of these pulses lead to switching on and the pulses obtained from the fall slope of these pulses to switching off of the firing magnet. The square wave generator comprises preferably a Miller-integrator with a following threshold stage. In this switching arrangement, one obtains square wave pulses with very steep slopes. From these ascending and descending slopes one obtains the switching on and the switching off pulses, after the pulses have been brought to a constant duration by a mono-stable multivibrator by means of differentiating into a differential circuit.

A push button switch is provided and the fire arm starts operation upon operating the push button switch. In order to render ineffective any contact bounce of the push button switch, in accordance with the present invention, a flip-flop is provided which, upon pushing down the push button switch, switches over and starts operation of the square wave generator. The Miller integrator and the following threshold stage can be designed in conventional manner, whereby the rate is preferably determined by an RC-time constant. For the selection of the cadence, in accordance with the present invention, one of the structural elements, for instance, the resistance, can be adjustably continuous or stepwise. In case of a continuous adjustment, suitably a multiplex potentiometer is used, the scale of which can be gauged in accordance with the set rate and cadence, respectively.

The duration of the starting pulses of the square wave generator depends, as a matter of course, upon the rate, since the set pulse width/repetition ratio does not vary in case of a frequency change.

In order to obtain, however, square wave pulses of constant pulse length, a mono-stable multivibrator follows the square wave generator. By this arrangement, one obtains square wave pulses of an independent and constant rate, respectively, the timely succession of which is determined by the settable rate of the square wave generator.

From the rising slope of the "square wave pulses of an independent and constant length, respectively," pulses are produced by means of a differentiator member following a pre-amplifier, which pulses serve the control of the electronic power switch (Thyristor), which switches on the electro-magnet.

When the electro-magnet has pulled through, it operates each time an end switch. The pulses produced thereby are fed to a second Thyristor which causes the switching off of the electro-magnet. It is, however, desirable to provide compulsory switch-off pulses, which can control the second Thyristor from the end switch. These compulsory switch-off pulses are obtained from the falling slopes of the square wave pulses of rate-independent and constant length.

Since the timely succession of switch-on pulses and compulsory switch-off pulses is determined by the maximum desired switch-on time of the electro-magnet, the timely succession of both these pulses must be correspondingly settable constant corresponding to the prevailing conditions. This is in this case assured such, that the switch-on pulse is gained from the rising slope and the compulsory switch-off pulse from the falling slope of a square wave pulse of constantly settable length.

The duration of the compulsory switch-off pulse is determined by a further mono stable sweep stage.

It is to be understood that the fire arm must be also capable of providing continuous firing and individual firing. For this reason, a selector switch is provided, whereby, in the position "control single fire," the previously described switching procedures take place. In the switch-over position "single firing," only one single pulse is fed to the differentiator circuit, independently from the operation duration of the push button switch. During the switch-over position "continuous firing" the switch-on Thyristor is continuously controlled and the fire arm works with the cadence, which is preset by the breech block times of the arms.

A burst control device, which is designed in accordance with the present invention, is divided suitably into individual constructional groups or structural units, whereby, for instance, one constructional group can be provided as a service device, a second as control step, a third as output stage, a fourth for the current feed, and a fifth for the fuses. This division according to the functions is recommended also for the reason, because it is often desirable or required that the individual constructional groups are disposed in spacial separation from each other, and the connections are brought about by longer or shorter cables. Thus preferably the structural unit "servicing," on the one hand, and the structural units "control," "output," "current feeding," "fuses," on the other hand, can be provided in housings connected with each other by cables. A further cable connection can lead to the electro-magnet provided of course on the fire arm itself.

The servicing structural unit can contain, for instance, the required selector switches, indicator lamps, the push-button switch and the setting potentiometer and, furthermore, also a connection for a burst control device. It is preferred to provided a key switch, without which the device cannot be rendered operative.

Furthermore, connections can be provided, preferably on the structural output unit, for the conventional end switches of the ammunition boxes, in order to switch-over from the right to the left ammunition box, as soon as it is required, and vice versa. This arrangement is suitable, when the fire arm is arranged for ammunition feed from right and left.

With these and other objects in view, which will become apparent in the following detailed description, the present invention, which is shown by example only, will be clearly understood in connection with the accompanying drawings, in which:

FIGURE 1 is a schematic spacial arrangement of the individual structural groups;

FIG. 2 discloses the operating connections in the case of the switch position "controlled individual fire";

FIG. 3 discloses the switching together of the firing magnet with the switch-on and the switch-off Thyristor; and

FIG. 4 is a diagrammatic showing of the time versus pulse diagram for the firing method "controlled individual fire."

Referring now to the drawings, and in particular to FIG. 1, the unit comprises a control device **1**, a voltage source **2**, a service device **3** and a firing magnet **4**. The control device **1** is divided into individual structural groups or units which are individually exchangeable and are connected together by means of multi-polar plugs, whereby the plug connections are preferably disconnected by withdrawl of the individual structural groups or units. The structural groups comprise voltage supplies **11**, fuse unit **12**, output unit **13** and a control unit **14**. The voltage source is connected with the voltage supply, the control unit with the service device and the output stage with the firing magnet. Furthermore, the service device has also a terminal **31** or a burst control device, and the terminals **131** and **132** for the end switch of the ammunition boxes are disposed on the output unit.

On the servicing device are disposed the selector switch for "single fire," "controlled single fire," and "duration fire," as well as the coordinated control lamps, furthermore, the key switch and the push-button switch, and finally the operating knob for the settable potentiometer, with which the firing succession is chosen. In addition, a selector switch "ammunition box right," "ammunition box left," and "magazine" can be provided. In the first two positions of the selector switch, only the particular ammunition box is used, while in the position "magazine," the ammunition status is not controlled.

FIG. 2 shows schematically the connections of the unit in case of the firing modus "controlled single fire" is selected. The push button switch **51** switches the flip-flop **52**, which acts as a switch amplifier for rendering ineffective any contact bouncing. As long as the flip-flop is set, in other words, as long as the push button switch is pressed down, the square wave generator **53** runs free with a pulse rate determined by the setting of the potentiometer, which pulse rate corresponds to the firing cadence. Since in response to a pulse rate variation the output pulse length varies, too, a mono-stable multivibrator **54** is provided, the output pulse length of which multivibrator **54** is substantially independent from the pulse rate. These output pulses are fed, on the one hand, to a differentiator **56** by means of the amplifier **55**. These amplified and differentiated square wave pulses are in turn fed to a switch-on Thyristor **57** which fires in response thereupon, thus closing the solenoid circuit. On the other hand, the output pulses of the monostable multivibrator **54** are fed to an inverter stage **58**, so that the length of the output pulses is equal to the pause between two output pulses of the monostable multivibrator. In order to shorten the output pulses of the inverter stage, they are applied to the sweep stage **59**, and, after being amplified by the amplifier **60** are supplied to the switch-off Thyristor **61**, which in response thereto interrupts solenoid circuit **4**. The switch-on and switch-off pulse follow each other spaced by periods determined by the pulse length of the monostable multivibrator **54**. The conditions are once more clearly disclosed in the diagrammatic showing of FIG. 4. The numerals equipped with a prime (′) characterize the output pulse of the corresponding stage. It should be remarked that conventional intermediate members (selector switches, fuses, amplifiers, indicator lamps, etc.) are not shown.

In the firing modus "single fire" and "duration fire," care is taken by switching over that the not required stages are then inoperative. The upper limit of the controllable firing succession is determined solely by the fire arm (advance and return stroke time) and by the attracting time of the magnet. Correspondingly, the maximum cadence is to be set which can be selected with the settable potentiometer. Consequently, it lies lower than the duration firing cadence. The square wave generator consisting of a Miller integrator with the following threshold stage is set for output frequencies between 0.003 c.p.s. and 20 c.p.s. at a pulse versus pause ratio of 1:1. Thus, a lowest settable cadence of about 10 shots per hour would be feasible. Suitably, one selects, however, the ratio between the highest and the lowest settable cadence not greater than 10:1, which can be realized without difficulties.

FIG. 3 shows schematically the interconnection of the solenoid with the switch-on and switch-off Thyristor. The circuit operates in the following manner: The firing of a switch-on Thyristor **57** closes the circuit which contains the solenoid **41** and the capacitor **40** is charged by the line voltage, so that the plate **1** carries positive potential. In response to a successive firing of the switch-off Thyristor **61**, the capacitor **40** is connected in parallel relation with respect to the switch-on Thyristor **57**, so that the voltage across the capacitor **40** acts as locking voltage for the latter. Thereby, the Thyristor **57** is switched off and the solenoid circuit is interrupted. The capacitor **40** is re-charged but, however, so that a positive potential occurs now on the plate **2**, current flowing via the resistor **39**. The operation is correspondingly similar and applies also when the switch-on Thyristor is again fired. The respective stages are preferably provided with conventional semi-conductor circuits, the design and operation of which are not subject matter of the present invention, but instead their interconnection and interaction.

We claim:

1. An electronic cadence control for "controlled individual shots" from automatic fire arms, the firing of which is performed by operation of an electromagnet, comprising

a square wave generator,

a monostable multivibrator,

the settable pulse rate of said square wave generator being equal to the desired cadence and its pulses being transformed into pulses of rate-independent and constant length, respectively, so that said pulses obtained from the rising slopes of said pulses lead to a switch-on of said electromagnet and said pulses obtained from the falling slopes of said pulses lead to a switch-off of said electromagnet,

said pulse formed stage comprising a flip-flop with settable constant output pulse length,

a selector switch for "single shots," "controlled single shots," and "permanent firing" being provided, and

in said switch-over position "single shots" upon operation of a push button switch a single pulse being fed to the differentiator circuit.

2. The electronic cadence control, as set forth in claim **1**, which includes

a bistable multivibrator, and

said flip-flop switches over upon operation of said push

button switch and starts operation of said square wave impulse generator.

3. The electronic cadence control, as set forth in claim **1**, wherein

the setting of the pulse rate of said square wave generator takes place in steps by switching over.

4. The electronic cadence control, as set forth in claim **1**, wherein

the setting of said pulse rate of said square wave generator takes place infinitely variably by means of a multiplex potentiometer.

5. The electronic cadence control, as set forth in claim **1**, wherein

said square ware generator comprises a Miller-integrator with a following limit value step.

6. The electronic cadence control, as set forth in claim **1**, wherein

said switch-on pulses and said switch-off pulses are obtained by differentiating of said pulses of constant length, and which includes,

a Thyristor for each and controlled by said pulses, and said pulses causes the switch-on-and-off of said electromagnet by means of said Thyristors.

7. The electronic cadence control, as set forth in claim **1**, which includes

a monostable stage, and the duration of said switch-off pulse is rigidly preset by said monostable stage.

8. The electronic cadence control, as set forth in claim **1**, wherein

in the switch-over position "permanent firing" upon operation of said pushbutton switch said switch-on Thryistor is permanently controlled, and

the cadence of the fire arm is determined only by the forward stroke and return stroke of the breech block.

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