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CONTROL SYSTEM

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Fig. 1.

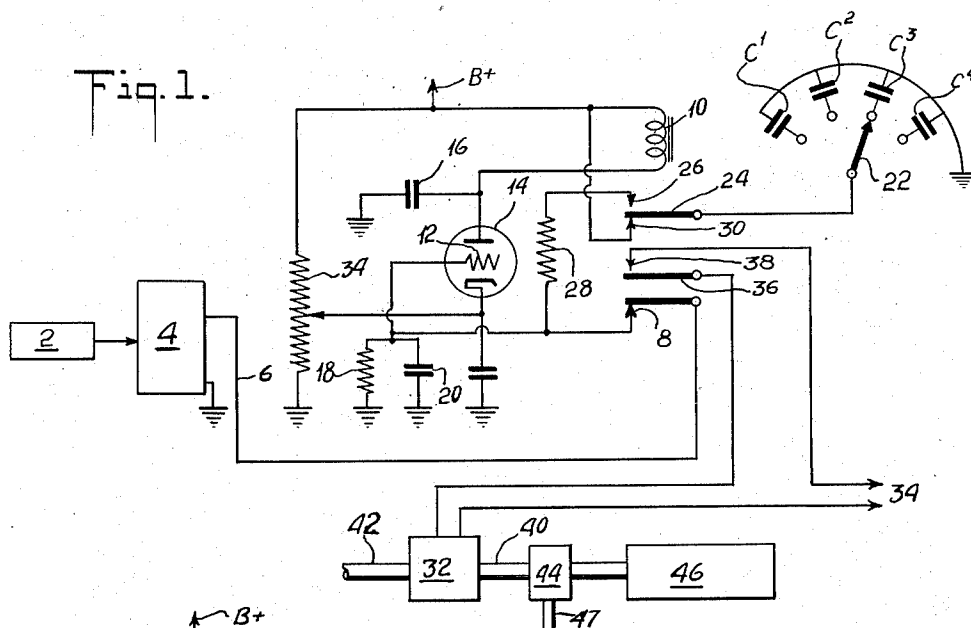


Fig. 2.

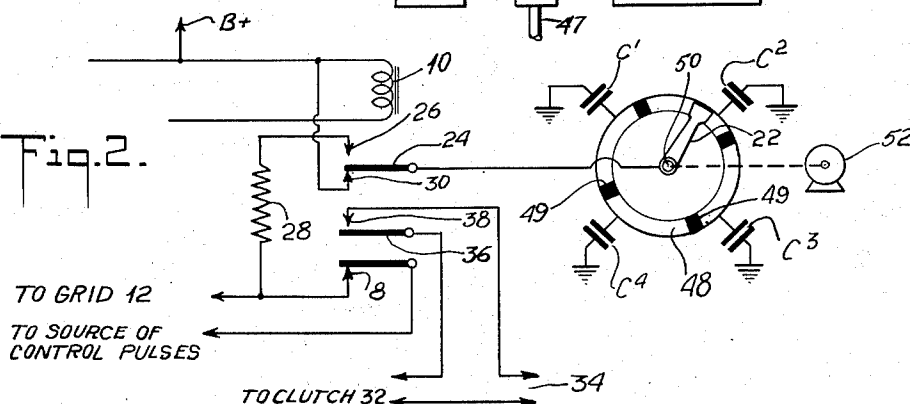
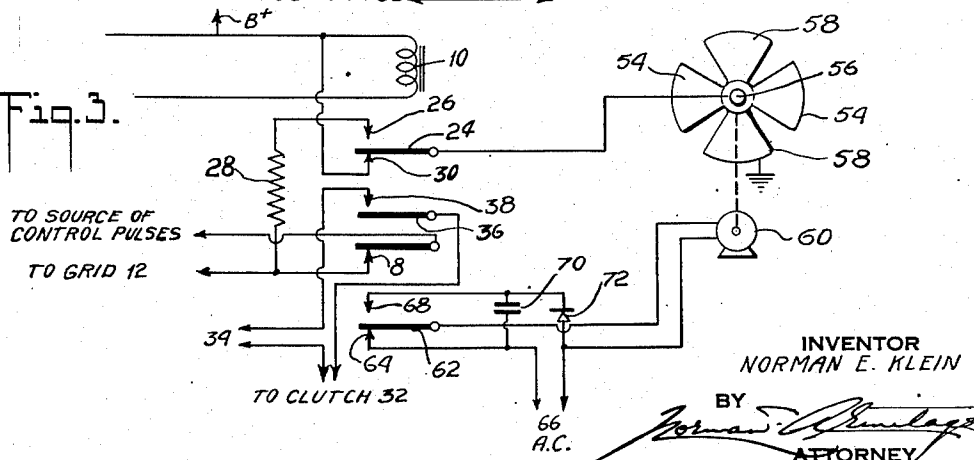


Fig. 3.



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CONTROL SYSTEM

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The present invention relates to control systems and more particularly to control systems of the type wherein a sequence of control signals controls one or a plurality elements. The invention comprises a novel system of this type wherein the control signals are of random occurrence and of constant or of random duration as desired. The control system of the invention, while of general application, is particularly adapted for use in controlling the manufacture of yarn to insert in the yarn randomly spaced slubs of constant or of random length.

In the control system of the invention inherently random phenomena, such as the incidence of cosmic radiation on a given surface, are transformed into a series of randomly occurring pulses and the pulses are used to initiate control signals. In one embodiment of the invention, each control signal, once initiated, continues for a period of time which is fixed by the setting of an adjustable member. In other embodiments of the invention, the signals are of random duration or may have any one of a number of randomly selected periods of duration. In the latter case the particular period of duration of any one control signal is unpredictable and is independent of that of the preceding or succeeding signal.

For an understanding of the invention reference may be had to the accompanying drawing, of which:

Fig. 1 illustrates diagrammatically a control system embodying the invention in which control signals of random occurrence and constant duration control mechanism for insertion of slubs into yarn;

Fig. 2 illustrates an alternative arrangement of one part of the system of Fig. 1 for use in inserting slubs of randomly selected lengths into yarn; and

Fig. 3 illustrates a second alternative arrangement of part of the system of Fig. 1 suitable for use in inserting slubs of random length into yarn.

In Fig. 1 a source of random phenomena is diagrammatically indicated at 2 and a device for detecting variations in the source 2 and converting such variations into a sequence of randomly occurring positive electrical pulses is indicated at 4. Source 2 may be, and preferably is, one, or a plurality, of counter tubes actuated upon penetration by cosmic rays or by radiation from radioactive material. Device 4, when source 2 is of the above described type, may be a simple amplifier or a coincident circuit or one or more scale-of-

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two circuits, depending upon the number and arrangement of the counter tubes in source 2, upon the type of radiation to which the counter or counters are exposed and upon the desired average rate of initiation of control signals. So far as the present invention is concerned, source 2 may be considered as a conventional cosmic ray actuated counter, such as a Geiger-Müller counter tube and device 4 may be considered as an amplifier and as a means for emitting a positive pulse upon each discharge of the counter of source 2. The randomly occurring positive pulses emitted by device 4 initiate control signals by means of the circuit now to be described.

The positive potential output lead 6 of device 4 is connected over a normally closed back contact 8 of a relay 10, with the control grid 12 of a triode 14. The cathode of triode 14 is connected to an adjustable tap on a resistor 34 connected across the power source, the positive terminal of which is indicated at B+. The cathode of tube 14 thus operates at positive bias. The plate of tube 14 is connected to B+ through the winding of the relay 10 and is connected to ground through a condenser 16. Control grid 12 is connected to ground through an RC network comprising a resistor 18 and bridging condenser 20. An adjustable contact arm 22 is connected to a second armature 24 of relay 10, the associated front contact 26 of which is connected to control grid 12 through a resistor 28 and the associated back contact 30 of which is connected to B+. Each of a plurality of condensers, C₁, C₂, C₃, and C₄ of different capacity, has one plate grounded and the other plate connected to a different fixed contact engageable by the contact arm 22.

The above described circuit provides means for initiating energization of relay 10 at random intervals and for maintaining the energization of this relay after each initiation thereof for a constant period of time, the length of the period depending upon the capacity of the particular condenser C₁, C₂, C₃ or C₄ connected in circuit with arm 22. Thus by adjustment of arm 22, as many different periods of duration of the control signals may be selected as there are different capacities in the condenser array. In the particular embodiment of the invention illustrated in the drawing, four different periods of duration can be selected, but obviously additional capacities could be provided, if desired, to increase the range of selection.

Random phenomena occurring in source 2

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cause a sequence of positive pulses to be emitted from device 4. These positive pulses are separated by periods of random duration, due to the random nature of the source. Each positive pulse is transmitted to the control grid 12 of triode 14 over the circuit including back contact 8 of relay 10. Each positive pulse impressed on grid 12 is sufficient to permit triode 14 to draw current and thereby energize relay 10. Relay 10, upon energization, picks up its armatures causing a condenser of the condenser array, specifically condenser C₃ for the position of arm 22 illustrated in Fig. 1, to be connected over front contact 26 and through resistor 28 to control grid 12, and breaking the circuit connecting grid 12 with lead 6 at the back contact 8. The condenser C₃ thus discharges to ground through the circuit including resistors 28 and 18 and this discharge current maintains control grid 12 sufficiently positive to prevent deenergization of tube 14 for the period of the discharge. Relay 10 is thus also maintained energized during the period of discharge of condenser C₃.

When the potential of control grid 12 drops sufficiently to block tube 14, relay 10 becomes deenergized, condenser C₃ is recharged from B+ and the control grid 12 is reconnected to lead 6 for reception of a subsequent positive pulse for initiation of a control signal. As heretofore indicated, by adjustment of arm 22 the period of duration of the control signals may be changed as desired.

The randomly occurring control signals of constant duration obtained by the above described circuit may have a wide variety of applications and may be used wherever it is desired to control an element after intervals of unpredictable duration.

Preferably the signals are used to insert slubs into yarn and for this purpose relay 10 may control the circuit of a device which, when energized, decreases the draft of a yarn drafting and spinning mechanism, as, for example, by increasing the rate of rotation of the feed or back rolls of the mechanism. In Fig. 1, such a controlled device is diagrammatically indicated as a magnetic clutch 32. The energizing circuit of the clutch includes a pair of terminals 34, connected to any suitable source of energy (not shown) an additional armature 36 of relay 10 and a front contact 38 associated with the armature 36. The clutch is thus energized during each control signal. When energized, it couples a shaft 40 to a drive shaft 42 and such coupling through suitable overriding clutches, or the like, indicated diagrammatically at 44, increases the rate of rotation of the driven feed roll 46 of a yarn drafting and spinning mechanism. The parts of the yarn drafting and spinning mechanism, other than the roll 46, have not been illustrated in the drawing as such mechanisms are well known and form no part of the present invention. It will be understood that during the intervals between control signals, the roll 46 is driven as usual from the main drive shaft 47 of the mechanism at a constant rate of rotation. During control signals, that is during energization of relay 10 and of magnetic clutch 32, the feed rolls are driven at an increased rate from shaft 42 through shaft 40 and the overriding clutch 44. The increased rate of rotation of the feed rolls decreases the draft of the mechanism and increases the diameter of the yarn and hence randomly spaced slubs of a length deter-

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mined by the period of duration of the control signals will be inserted in the yarn.

As heretofore indicated, the slubs inserted into the yarn by the system of Fig. 1 will all be of the same length and this length may be changed by adjustment of the position of arm 22 to connect a different one of the capacities C₁, C₂, C₃ and C₄ to armature 24. The system of Fig. 1 may be readily modified, if desired, for production of yarn with slubs of different length therein. For this purpose means may be provided for continuously or intermittently moving arm 22 over the fixed contacts connected to the respective condensers of the array. Fig. 2 illustrates diagrammatically such an arrangement.

In Fig. 2 the four condensers, C₁, C₂, C₃, and C₄ are shown with one plate of each connected to a different arcuate conducting segment of a ring 48. The arcuate segments are insulated from each other by short nonconducting segments 49. The conducting arm 22 is carried by a shaft 50 which is continuously rotated at a relatively low rate by means indicated diagrammatically as a motor 52. The arm 22 is electrically connected by suitable slip rings or brushes (not shown) to the armature 24 of relay 10. Hence, during intervals between signals, the condensers are successively connected to B+ over the back contact 30 associated with armature 24 as the end of arm 22 in its rotation successively engages the conducting segments of the ring 48. When relay 10 is energized one of the condensers C₁, C₂, C₃, and C₄ will discharge over the circuit comprising the armature 24, front contact 26 and resistors 28 and 18 to hold relay 10 energized for the period of discharge. The particular condenser which discharges will depend upon the position of arm 22 at the moment of initiation of the control signal. As the length of time between any two successive signals has no relation to the rate of rotation of arm 22, the duration of any one signal will have no relation to that of the preceding or succeeding signal and hence, when slub injecting apparatus is controlled by the system, the length of any one slub will have no relation to that of the preceding or succeeding slub. To avoid the very short signals that would result when a pulse arrives at the grid 12 just prior to passage of the contact arm from a conducting segment or ring 48 and also to obtain additional periods of duration resulting from momentary connection of adjacent condensers of the array in parallel, the insulating segments 49 may be made short enough to be bridged by the contact arm 22.

Instead of providing a plurality of condensers of different capacities for control of the durations of the control signals, as in Figs. 1 and 2, a movable plate type of condenser could be provided as indicated in Fig. 3. In this arrangement the armature of relay 10 is connected, by suitable slip rings or brushes, not shown, to a pair of vanes 54 comprising the movable element of a condenser. The vanes 54 are mounted on a shaft 56 for rotation therewith. The fixed element of the condenser comprises a pair of grounded vanes 58 fixedly positioned adjacent the vanes 54. During intervals between control signals; that is during periods of deenergization of relay 10, the vanes 54 are connected to B+ over the back contact 30 of armature 24 of relay 10, and the shaft 56 carrying these vanes is rotated by means of a small A. C. motor 60 so as to vary continuously the capacity of the assembly. Rotation of shaft 56 is preferably

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arrested during each control signal and for this purpose the circuit of the motor 60 is controlled over an additional armature 62 of relay 10, the energizing circuit of the motor including the armature 62 and a back contact 64 associated therewith. Energy is supplied to the motor 60 from any suitable source of alternating current (not shown), connected to the terminals 66. To provide braking of the motor upon initiation of a control signal, a front contact 68 associated with the armature 62 is connected through a capacity 70 with the back contact 64 and, through a rectifier 72, with that one of the motor terminals connected with the power source. Thus when relay 10 is energized to pick up its armatures, condenser 70 discharges through the circuit including front contact 68, armature 62 and the winding of the motor and this discharge current brakes the motor.

With the above described arrangement of Fig. 3, the duration of any control signal will depend upon the particular position of the vanes 54 at the moment of initiation of the signal, as such position determines the capacity of the condenser and hence the rate of decay of the discharge current through resistance 28 and the network associated with the control grid 12 of the tube controlling relay 10. During intervals between signals, the capacity is continuously varied by rotation of the vanes 54 by the motor 60 and the condenser is charged from B+ over the back contact 30 of armature 24. Thus this alternative arrangement provides truly random duration of the control signals, rather than a random selection of specific durations, as in the arrangement of Fig. 2. Obviously, if desired, a movable plate condenser of the type of Fig. 3, could be substituted for the condenser array of Fig. 1 wherein a limited number of discrete capacities are available for adjustment of the duration of the control signals.

The control system of the invention has now been described with particular reference to its application to the production of yarn having slubs therein at random intervals and of fixed or of random lengths as desired. In the particular embodiment of the invention illustrated in Fig. 1, the control system has been indicated as controlling the insertion of slubs into yarn by increase of the rate of rotation of the feed rolls of a yarn spinning and drafting mechanism to reduce the draft thereof. It will be understood that the draft could be reduced without increase of rate of feed roll rotation, for example by change in ratch length, or by decrease in rate of rotation of the draft rolls or by change of location of feed of the roving into the ratch, in the case of conical feed rolls, and that slubs could be injected into yarn without change of draft, for example by the addition of loose fibers to the roving. Also slubs could be injected into continuous filament yarn during extrusion or spinning thereof or during stretch breaking and drafting thereof.

The control system of the invention could be advantageously employed for purposes other than injection of slubs into yarn. For example, novel non-repetitive printing effects on fabrics, or on wall coverings or other surfaces, could be obtained in accordance with the invention by control of a printing element in response to the random control signals, or the random control signals could be used to provide erratic and unpredictable movement of a target in a shooting gallery or unpredictable direction of projection or

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of time of release of the targets in trap shooting. Other applications of the invention to fields wherein random variations of a characteristic of an article or an erratic sequence of events may be desired will occur to those skilled in the art.

Obviously various changes, both in the described method of the invention and in the specific means illustrated and described herein, could be made without departing from the spirit of the invention. For example, although in the normal practice of the invention the randomly occurring control signals would be utilized concurrently with their production, as described in connection with each of the illustrated embodiments, their use may be delayed if desired, either for predetermined periods, as by inclusion of delay circuits, or for indefinite periods as by inclusion of recording and reproducing means in the system. Also, although in each of the illustrated embodiments of the invention, but one mechanism has been indicated as controlled by the sequence of control signals, obviously any number of mechanisms could be simultaneously controlled in response to the same signals. Also the control signals of random occurrence and of fixed or random length could be given a third random characteristic, for example magnitude, as disclosed and claimed in the copending application of Fred P. Strother, Ser. No. 3776, filed January 22, 1948, and one or a plurality of elements may be controlled by such modified signals. Although it is preferred that the source of random phenomena be one or a plurality of counter tubes actuated by cosmic or similar radiation, as hereinbefore discussed, the source of random phenomena may be any one that is statistically variable, that is, one wherein there are a great number of independently variable elements which are individually unpredictable but collectively stable and the variations thereof susceptible of detection.

The following is claimed:

1. A control system comprising in combination means for detecting randomly occurring radiations, means for producing a sequence of pulses, means responsive to said first mentioned means for initiating a control signal upon the occurrence of a pulse, means responsive to initiation of a control signal for maintaining the control signal for a predetermined period of time, and means associated with said last-mentioned means including a continuously varying element, the position of which at the moment of initiation of a control signal determining the period during which a signal is maintained.

2. A control system comprising in combination, means for producing a sequence of randomly occurring pulses, means for initiating a control signal upon the occurrence of a pulse, a storage device, means for initiating discharge of the storage device upon initiation of a control signal, means responsive to initiation of a control signal for maintaining the control signal for the period of discharge of the storage device, means for recharging the storage device between control signals, and means for continuously varying the capacity of the storage device to randomly vary the period of duration of the randomly produced control signals.

3. A control system comprising in combination a source of random phenomena means for converting phenomena from said source into a series of randomly occurring pulses, a circuit controlling device adapted when energized to produce a control signal, means responsive to a pulse for

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initiating energization of said device; a variable storage device; means responsive to energization of said circuit controlling device for initiating discharge of said storage device; means controlled by the discharge of said storage device for maintaining said circuit controlling device energized whereby the period of duration of a control signal initiated by a pulse is determined by the capacity of said storage device; and means for continuously varying the capacity of said storage device between fixed limits during intervals between control signals whereby the period of duration of any control signal is made to depend upon the capacity of said storage device at the moment of initiation of a control signal.

4. The method of producing a novelty yarn which comprises creating a sequence of pulses, initiating a control signal in response to a created pulse, initiating discharge of a storage device in response to a control signal, maintaining the signal during the period of discharge of the storage device and actuating an element affecting the diameter of yarn for the duration of the control signal.

5. Apparatus for producing yarn having slubs at intervals therein comprising in combination means for creating a series of pulses, means responsive to a pulse for initiating a control signal, a storage device, means responsive to a control signal for initiating discharge of said device, means responsive to discharge of the storage device for maintaining the control signal for the period of discharge of the device, a yarn spinning mechanism and means associated therewith and responsive to the control signal for inserting slubs into yarn spun by said mechanism.

6. Apparatus according to claim 5 including means for varying the capacity of the storage device to vary correspondingly the duration of the control signals and the length of slubs inserted into yarn by said mechanism.

7. Apparatus for producing yarn having randomly spaced slubs therein comprising in combination a source of random phenomena, means for converting phenomena from said source into a series of randomly occurring pulses, a normally deenergized electronic tube connected for energization during occurrence of a pulse, a

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storage device, means responsive to energization of said tube for initiating discharge of said storage device, means controlled by the discharge of said storage device for maintaining said tube energized, a yarn spinning mechanism and means associated therewith and responsive to energization of said tube for inserting slubs into yarn spun by said mechanism.

8. Apparatus according to claim 7 including means for varying the capacity of said storage device to vary correspondingly the duration of the periods of energization of said tube and the lengths of the slubs inserted into yarn by said mechanism.

9. Apparatus according to claim 7 including means for automatically varying the capacity of said storage device at least during the intervals between the periods of energization of said tube whereby slubs of random length are inserted into the yarn.

10. The method of producing control signals which comprises utilizing a source of inherently random phenomena to create randomly occurring pulses, initiating a control signal in response to a created pulse, initiating discharge of a storage device in response to a control signal, maintaining the signal during the period of discharge of the storage device, and continuously varying the capacity of the storage device between fixed limits to randomly vary the period of duration of the randomly produced control signals.

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