

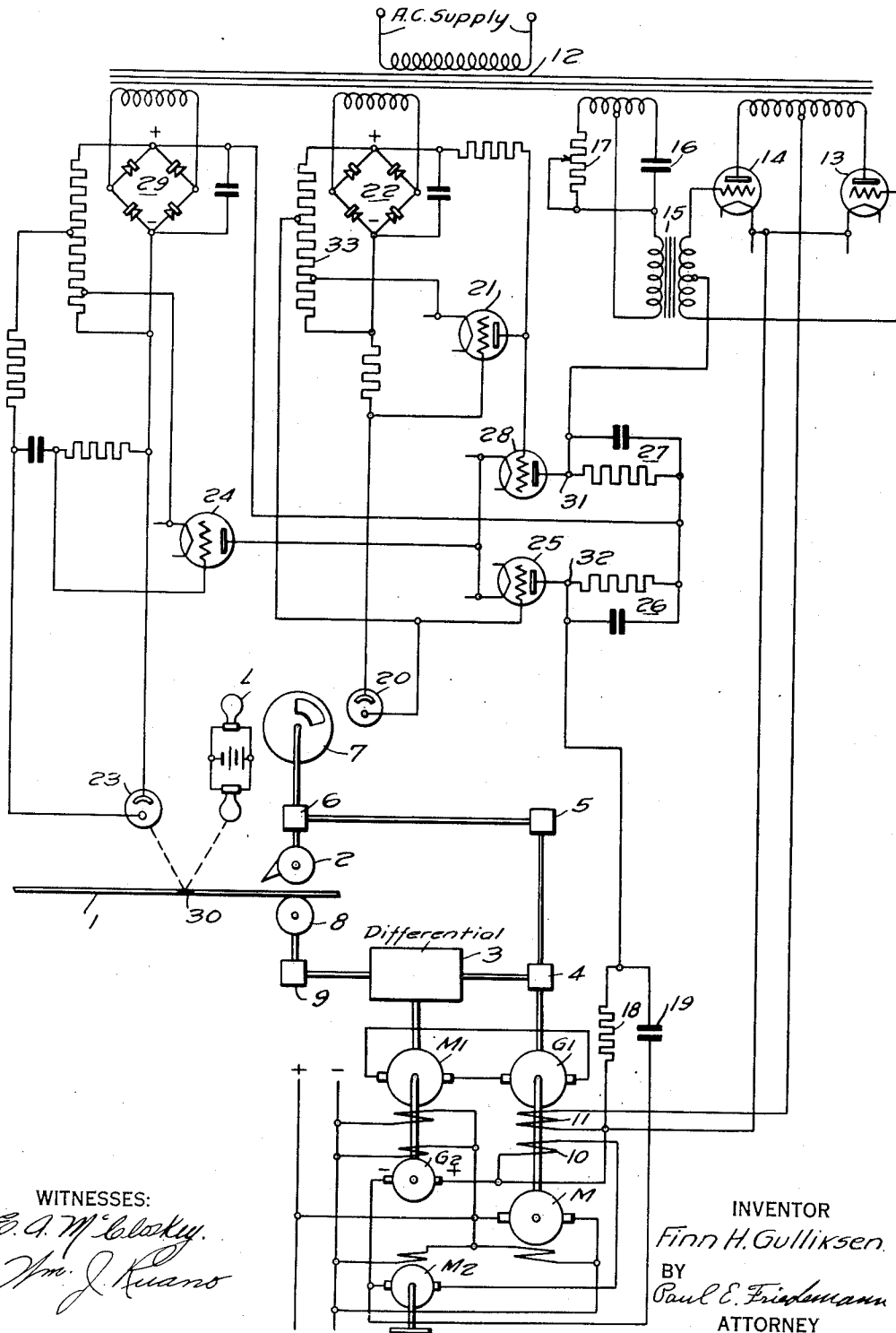
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REGISTER REGULATOR

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REGISTER REGULATOR

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My invention relates to electrical control systems for apparatus operating on material.

More specifically, this invention relates to electrical control systems involving thermionic means and light-sensitive means for controlling the relative positions and relative speeds of certain parts of a machine operating on a web of material.

In the art of paper cutting, winding, printing, or other manufacturing processes, such as the making of bags, the operation of the paper or web of material, when moving from a supply reel past certain rolls to the cutter, or to other parts of the machine, nearly always involves slippage, whereby the paper becomes shifted relative to the cutter or other machine element. Even when there be no slippage, the hygroscopic characteristics of paper, or temperature, or both, will cause a change in its dimensions, and also its surface characteristics, with changes of relative humidity and/or changes in temperature, with the result that certain machine elements will not register with the paper in the desired manner. Slippage and the moisture effect may, of course, occur simultaneously.

One object of my invention is to provide for properly registering certain regions of a material being operated upon by a machine with certain elements of the machine.

It is another object of my invention to control the operation of apparatus operating on a web so that the required operation on the web will take place at the right point, regardless of slippage of the web, or changes of dimensions or the surface characteristics thereof.

It is also an object of my invention to provide means for correcting in one continuous operation each departure from registry of a material and certain elements of a machine operating on it.

Another object of my invention is to control the relative speeds of a cutter and the feeding means of a machine, operating on a web, by means of photo-electric control means.

A further object of my invention is to control the position of the web, in a machine operating on a web, by photo-electric control means.

It is also an object of my invention to provide electronic selective control means for controlling the direction of operation of a motor or other electrical device in response to variations in position of a mark on a material operated upon by a machine.

Another object of my invention is to control the relative speeds of certain parts of a machine operating on a web and the relative positions of

these parts by the cooperative action of photo-electric and thermionic means.

A broad object of my invention is to provide photo-electric control means, unaffected by changes in color of the material being operated upon by a machine or by changes in appearance or by changes in the character or the condition of the material, to control the machine so that certain elements of the machine are caused to register with the indicia which may be either on or in the material.

A still further broad object of my invention is to provide a compensating control system, including photo-electric means for compensating for changes in the color and depth of color of the web, shade of the web and the character, shade and color of the indicia which may be either on or in the web, to register certain elements of a machine operating on a web with selected regions of the web.

A specific object of my invention is to provide a particular speed changing device for effecting correction of speed of a web of material to a predetermined optimum value, when speed changing device will function solely on condition that a statically operated discharge tube and an impulse actuated discharge tube (both photo-electrically controlled) are both operated simultaneously.

Another specific object of my invention is to provide a register regulator which has a high speed of correction but which is devoid of hunting.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments, when read in connection with the accompanying drawing, in which the single figure is a diagrammatic representation of an electrical control system embodying my invention.

Referring more particularly to the drawing, a web of paper 1 or other sheet material is intermittently cut (once per revolution) by a rotating cutter knife (or perforator, or other operating means) 2 by means of a drive extending from the main driving motor M through bevel gears indicated by numerals 4, 5 and 6. Coupled to bevel gear 6 and suitable reduction gearing (not shown) is a scanning disc 7 (or intermittently operative shutter) having a slot therein which allows passage of a light beam therethrough from

a light source L, onto photo-tube 20 once every revolution of the scanning disc. A feed roller 8, the speed of which controls the rate of paper feed, is coupled through bevel gear 9 and a mechanical differential gear mechanism 3 to the drive shaft of the main motor at bevel gear 4.

The paper 1 is normally being fed slightly too fast or too slow to the rotating cutter knife 2, and the mechanical differential operated by motor M1 is used to maintain registry between the paper and the cutter. If, for example, the paper is fed too slow, the motor M1 should be so connected that when the motor operates at maximum speed the operation of the mechanical differential causes the paper to feed too fast. By adjusting the speed of motor M1 it is, therefore, possible to register the paper with the cutter 2. The control of the motor speed is obtained by adjusting the armature voltage of pilot generator G1 by adjusting the field current of the pilot generator in accordance with the deviation in paper registry relative to the cutter. In the past, various adjusting schemes have been proposed, such as that involving the use of time delay relays for affording adjustment for a predetermined period of time. The equipment described so far is well known and does not involve my present invention. My copending application Serial No. 201,950, filed April 14, 1938, (now Patent No. 2,195,006, March 26, 1940), entitled "Register regulator control" and of which the present application is a continuation-in-part discloses such a system.

It is apparent that an arrangement of this type will have an inherent tendency to over-compensate if the speed of response be made high, as it is in a control system according to my invention, so that hunting will result, thus giving decreased accuracy of control. To eliminate hunting, I propose to couple a pilot generator G2 to motor M1. The voltage of this pilot generator is proportional to the speed of motor M1. Generally stated, the armature voltage of pilot generator G2 is connected to a capacitor-resistor circuit, which acts on the grid circuit of the tubes supplying current to one field winding of pilot generator G1 so that the voltage of this generator is modulated prior to the instant when the paper attains the correct register position.

In addition to this anti-hunting feature I provide a dynamic capacitor type anti-hunting circuit as described in my copending application, Serial No. 273,861, filed May 16, 1939, (now Patent No. 2,221,579, November 12, 1940), entitled "Voltage regulators" also of which the present application is a continuation-in-part. This anti-hunting circuit consists of an idler motor M2 which is equipped with a flywheel and which is connected in series with one field winding 10 of pilot generator G1 across the armature of pilot generator G2. If the speed of motor M1 changes as a result of the corrective action of the register regulator, the interchange current between pilot generator G2 and motor M2, acts on field winding 10 of pilot generator G1 so as to modify the armature voltage to oppose the initial change in speed of motor M1.

The position of the paper is indicated in the usual manner by means of printed spots 30 reacting on a scanner of well known design. The position of the cutter is indicated by means of a selector scanner. This scanner consists of the slotted disc 7 connected to the cutter shaft, a photo-tube and a light source. The photo-tube

20 is illuminated only if the cutter is in a definite predetermined position.

The electronic control circuits are as follows: A transformer 12 is connected to an alternating current supply source. Thyatron tubes 13 and 14 supply rectified current to one field winding 11 of pilot generator G1. The grid circuit voltage of tubes 13 and 14 consists of an alternating current component obtained from transformer 15 through the phase shifting circuit consisting of capacitor 16 and resistor 17.

This phase shift circuit is adjusted so that when the direct current grid voltage component (that is the direct current voltage occurring between points 31 and 32) is zero, the excitation of pilot generator G1 is of such a value that the paper speed is equal to the cutter speed. By changing the magnitude and the polarity of the direct current grid voltage component, the current through tubes 13 and 14 and the voltage of pilot generator G1 can be varied from zero to maximum value.

Photo-tube 23 is mounted in the spot scanner and is connected to high vacuum tube 24 in a well known impulse type circuit, that is, one whose conductivity varies solely in accordance with the rate of change of potential on its grid instead of a sustained value thereof as in static controlled tubes. The "impulse" type control for the light sensitive device may be broadly referred to as a dynamic pick-up means, whereas the static control may be broadly referred to as a static pick-up means. Tube 24 is connected across the direct current supply source obtained from full wave rectifier 29, and is series connected with high vacuum tubes 25 and 28, and the energy storing, self-compensating capacitor-resistor circuits 26 and 27. The purpose of capacitor resistor circuits 26 and 27 is to prolong the duration of the impulse voltage on the grid with respect to the wave of the alternating current source of supply. Each time a spot 30 on the paper intercepts the light beam reflected to photo-tube 23, tube 24 is temporarily made conductive, and current will flow either through resistor-capacitor combination 26 or 27, dependent upon the position of the cutter 2 at that instant. If it be assumed that the impulse (peaked) wave form of tube 23 is symmetrical about a vertical line going through its maximum value, then only during the moment of transition between illumination and darkening (or vice versa) of photo-tube 20, while the maximum value of impulse current occurs in tube 24, is the system indicative that the cutter and paper are in registry and no correction will occur. This is because equal portions of the impulse wave go through both resistor condenser combinations 26 and 27 and as the result there will be no direct current component between points 31 and 32. Illumination of photo-tube 20 may indicate "too fast" and darkening may indicate "too slow" (or vice versa), provided that the impulse or a greater portion thereof occurs during such condition of the photo-tube.

The grid control for tubes 25 and 28 is obtained from high vacuum tube 21 which is connected in series with a resistor 33 across the direct current voltage supplied by rectifier 22. If the selector scanner photo-tube 20 is illuminated, tube 21 conducts current and the grid of tube 25 is positive, and the grid of tube 28 is negative. In this case capacitor 26 in circuit becomes charged up when the impulse on photo-tube 23 occurs, and the current through tubes 13 and 14 is decreased. If photo-tube 20 is not illuminated, the opposite conditions result, that is, the grid

of tube 25 will be positive and that of tube 28 will be negative, therefore, charging the capacitor of circuit 27; thus when an impulse on phototube 23 occurs, the current through tubes 13 and 14 will increase.

The electronic anti-hunting circuit consists of resistor 18 and capacitor 19. Resistor 18 is connected in the grid circuit of tubes 13 and 14 so that when the voltage of pilot generator G2 is increased, the grid voltage of tubes 13 and 14 is made more negative. While light sensitive pick-up means have been described, it will be apparent that insofar as the broader aspects of the invention are concerned, other pick-up means such as condensers or inductance coils may be substituted therefor even though they do not have all the advantages of the light sensitive pick-up means.

I am, of course, aware that others, particularly after having had the benefit of the teachings of my invention, may devise other devices embodying my invention, and I, therefore, do not wish to be limited to the specific showings made in the drawing and the descriptive disclosure hereinbefore made, but wish to be limited only by the scope of the appended claims and such prior art that may be pertinent.

I claim as my invention:

1. A register regulator control system for web material, comprising, in combination, a main driving motor, an intermittently operative shutter driven thereby, said web having indicia thereon, a speed changing device, said web being driven by said driving motor through said speed changing device, means for registering the position of said web with respect to that of said shutter which includes a light sensitive, statically controlled electronic pick-up means which is operated by said shutter and a light sensitive, dynamically controlled electronic pick-up means which is operated by indicia on said web, circuit means interconnecting said speed changing device and both of said pick-up means for making said speed changing device variable only on condition that said dynamically controlled pick-up means is actuated at the same time said static controlled pick-up means is being actuated.

2. A register regulator control system for web material, comprising, in combination, a main driving motor, an intermittently operative shutter driven thereby, said web having indicia thereon, a speed changing device, said web being driven by said driving motor through said speed changing device, means for registering the position of said web with respect to that of said shutter which includes a light sensitive device which is intermittently illuminated by said shutter, a static controlled electric discharge device which is controlled by said light sensitive device, a second light sensitive device energized by said web indicia, an impulse controlled electric discharge device controlled by said second light sensitive device, circuit means interconnecting said speed changing device and said electric discharge devices so that said speed changing device is varied solely when both of said electric discharge devices are operated simultaneously.

3. A register regulator control system for web material, comprising, in combination, a main driving motor, an intermittently operative shutter driven thereby, said web having indicia thereon, a speed changing device, said web being driven by said driving motor through said speed changing device, means for registering the position of said web with respect to that of said

shutter which includes a light sensitive device which is intermittently illuminated by said shutter, a static controlled electric discharge device which is controlled by said light sensitive device, a second light sensitive device, an impulse controlled electric discharge device controlled by said second light sensitive device, circuit means interconnecting said speed changing device and said electric discharge devices so that said speed changing device is varied solely when said second light sensitive device is given a corrective impulse by said indicia at the same time said shutter opens to allow illumination of said first light sensitive device or closes to interrupt such illumination.

4. A register regulator control system for web material, comprising, in combination, a main driving motor, an intermittently operative shutter driven thereby, said web having indicia thereon, a speed changing device, said web being driven by said driving motor through said speed changing device, means for registering the position of said web with respect to that of said shutter which includes a light sensitive device which is intermittently illuminated by said shutter, a static controlled electric discharge device which is controlled by said light sensitive device, a second light sensitive device energized by said web indicia, an impulse controlled electric discharge device controlled by said second light sensitive device, circuit means interconnecting said speed changing device and said electric discharge devices, said circuit means including a direct current source, a second pair of electric discharge devices connected in parallel with said direct current source, each of which includes an anode, cathode and grid, the grids of said second pair of electric discharge devices being alternately controlled in response to change in illumination of said static controlled discharge device at the same time that said impulse controlled discharge device is operative, thereby imposing a control on said speed changing device so as to either increase or decrease the speed thereof to effect registry of said web with respect to said shutter.

5. A register regulator control system for web material, comprising, in combination, a main driving motor, an intermittently operative shutter driven thereby, said web having indicia thereon, a speed changing device, said web being driven by said driving motor through said speed changing device, means for registering the position of said web with respect to that of said shutter which includes a light sensitive device which is intermittently illuminated by said shutter, a static controlled electric discharge device which is controlled by said light sensitive device, a second light sensitive device energized by said web indicia, an impulse controlled electric discharge device controlled by said second light sensitive device, circuit means interconnecting said speed changing device and said electric discharge devices, said circuit means including a direct current source, a second pair of electric discharge devices connected in parallel with said impulse controlled discharge device and said direct current source, each of which includes an anode, cathode and grid, the grids of said second pair of electric discharge devices being alternately controlled selectively in response to the particular current conducting characteristic of said static controlled discharge device which occurs at the same time that said impulse controlled discharge device is operative, thereby

imposing a control on said speed changing device so as to either increase or decrease the speed thereof, to effect registry of said web with respect to said shutter.

6. A register regulator control system for web material, comprising, in combination, a main driving motor, an intermittently operative shutter driven thereby, said web having indicia thereon, a speed changing device, said web being driven by said driving motor through said speed changing device, means for registering the position of said web with respect to that of said shutter which includes a light sensitive device which is intermittently illuminated by said shutter, a static controlled electric discharge device which is controlled by said light sensitive device, a second light sensitive device energized by said web indicia, an impulse controlled electric discharge device controlled by said second light sensitive device, circuit means interconnecting said speed changing device and said electric discharge devices, said circuit means including a direct current source, a second pair of electric discharge devices connected in parallel with said impulse controlled discharge devices and said direct current source, each of which includes an anode, cathode and grid, the anode circuits of each said second pair of discharge devices including a parallel connected condenser and resistor unit, the grids of said second pair of electric discharge devices being alternately controlled selectively in response to the particular current conducting characteristic of said static controlled discharge device which occurs at the same time that said impulse controlled discharge device is operative, thereby imposing a control on said speed changing device so as to either increase or decrease the speed thereof to effect correction of the speed of the web so as to restore said web into registry with said shutter.

7. A register control system for web material, comprising, in combination, a main driving motor, operating means driven in synchronism with said motor, a speed changing device, said web being driven by said driving motor through said speed changing device, indicia on said web, means for registering the position of said web with respect to that of said operating means including a statically controlled pick up means which is operated by said operating means, and a dynamically controlled pick up means which is operated by indicia on said web, said speed changing device being variable to increase or decrease the speed of said web solely when said dynamically controlled pick up means is actuated at the same time that said static controlled pick up means is being actuated, said speed changing device including a mechanical differential which is interposed between said main driving motor and a feed roller for feeding said web, a pilot motor and pilot generator both coupled to one of the elements of said differential, a second pilot generator having separate field windings one of said generator field windings being variably energized in response to simultaneous operation of both of said pick up means and the other of which is connected in series with said first mentioned pilot generator armature thereby being effective to vary the speed of said pilot motor in accordance with deviations of the speed of said web from its normal value thus changing the transmission ratio of said mechanical differential and correcting the speed of said web.

8. A register control system for web material,

comprising, in combination, a main driving motor, operating means driven in synchronism with said motor, a speed changing device, said web being driven by said driving motor through said speed changing device, indicia on said web, means for registering the position of said web with respect to that of said operating means including a statically controlled pick up means which is operated by said operating means, and a dynamically controlled pick up means which is operated by indicia on said web, said speed changing device being variable to increase or decrease the speed of said web solely when said dynamically controlled pick up means is actuated at the same time that said static controlled pick up means is operated, said speed changing device including a mechanical differential which is interposed between said main driving motor and a feed roller for feeding said web, a pilot motor and pilot generator both coupled to one of the elements of said differential, a second pilot motor, a second pilot generator having separate field windings one of said generator field windings being variably energized in response to simultaneous operation of both of said pick up means and the other of which is connected in series with said first mentioned pilot generator armature and said second pilot motor armature thereby being effective to vary the speed of said pilot motor in accordance with deviations of the speed of said web from its normal value thus changing the transmission ratio of said mechanical differential and correcting the speed of said web and registering said web with respect to said operating means.

9. A register control system for web material, comprising, in combination, a main driving motor, operating means driven in synchronism with said motor, a speed changing device, said web being driven by said driving motor through said speed changing device, indicia on said web, means for registering the position of said web with respect to that of said operating means including a statically controlled pick up means which is operated by said operating means, and a dynamically controlled pick up means which is operated by indicia on said web, said speed changing device being variable to increase or decrease the speed of said web solely when said dynamically controlled pick up means is actuated at the same time that said static controlled pick up means is being actuated, said speed changing device including a mechanical differential which is interposed between said main driving motor and a feed roller for feeding said web, a pilot motor and pilot generator both coupled to one of the elements of said differential, a condenser and resistor connected in series across the armature of said pilot generator, a second pilot generator having separate field windings one of said generator field windings being variably energized in response to simultaneous operation of both of said pick up means and the other of which is connected in series with said first mentioned pilot generator armature thereby being effective to vary the speed of said pilot motor in accordance with deviations of the speed of said web from its normal value thus changing the transmission ratio of said mechanical differential, correcting the speed of said web and restoring said web into registry with said operating means.

10. A register regulator control system for web material, comprising, in combination, a main driving motor, an intermittently operative shutter driven thereby, said web having indicia thereon,

a speed changing device, said web being driven by said driving motor through said speed changing device, means for registering the position of said web with respect to that of said shutter which includes a light sensitive device which is intermittently illuminated by said shutter, a static controlled electric discharge device which is controlled by said light sensitive device, a second light sensitive device energized by said web indicia, an impulse controlled electric discharge device controlled by said second light sensitive device circuit means interconnecting said speed changing device and said electric discharge devices so that said speed changing device is varied solely when both of said electric discharge devices are operated simultaneously, said speed changing device including a mechanical differential which is interposed between said main driving motor and a feed roller for feeding said web, a pilot motor and pilot generator both coupled to one of the elements of said differential, a second pilot generator having separate field windings one of said generator field windings being variably energized in response to simultaneous operation of both of said pick up means and the other of which is connected in series with said first mentioned pilot generator armature thereby being effective to vary the speed of said pilot motor in accordance with deviations of the speed of said web from its normal value thus changing the transmission ratio of said mechanical differential, correcting the speed of said web and restoring said web into registry with said shutter.

11. A register regulator control system for web material, comprising, in combination, a main driving motor, an intermittently operative shutter driven thereby, said web having indicia thereon, a speed changing device, said web being driven by said driving motor through said speed changing device, means for registering the position of said web with respect to that of said shutter which includes a light sensitive device which is intermittently illuminated by said shutter, a static controlled electric discharge device which is controlled by said light sensitive device, a second light sensitive device energized by said web indicia, an impulse controlled electric discharge device controlled by said second light sensitive device circuit means interconnecting said speed changing device and said electric discharge devices so that said speed changing device is varied solely when both of said electric discharge devices are operated simultaneously, said speed changing device including a mechanical differential which is interposed between said main driving motor and a feed roller for feeding said

web, a pilot motor and pilot generator both coupled to one of the elements of said differential, a second pilot motor, a second pilot generator having separate field windings one of said generator field windings being variably energized in response to simultaneous operation of both of said pick up means and the other of which is connected in series with said first mentioned pilot generator armature and said second pilot motor armature thereby being effective to vary the speed of said pilot motor in accordance with deviations of the speed of said web from its normal value thus changing the transmission ratio of said mechanical differential, correcting the speed of said web and restoring said web into registry with said shutter.

12. A register regulator control system for web material, comprising, in combination, a main driving motor, an intermittently operative shutter driven thereby, said web having indicia thereon, a speed changing device, said web being driven by said driving motor through said speed changing device, means for registering the position of said web with respect to that of said shutter which includes a light sensitive device which is intermittently illuminated by said shutter, a static controlled electric discharge device which is controlled by said light sensitive device, a second light sensitive device energized by said web indicia, an impulse controlled electric discharge device controlled by said second light sensitive device circuit means interconnecting said speed changing device and said electric discharge devices so that said speed changing device is varied solely when both of said electric discharge devices are operated simultaneously, said speed changing device including a mechanical differential which is interposed between said main driving motor and a feed roller for feeding said web, a pilot motor and pilot generator both coupled to one of the elements of said differential, a condenser and resistor connected in series across the armature of said pilot generator, a second pilot generator having separate field windings one of said generator field windings being variably energized in response to simultaneous operation of both of said pick up means and the other of which is connected in series with said first mentioned pilot generator armature thereby being effective to vary the speed of said pilot motor in accordance with deviations of the speed of said web from its normal value thus changing the transmission ratio of said mechanical differential, correcting the speed of said web and restoring said web into registry with said shutter.

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