

Aug. 5, 1941.

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2,251,306

LIGHT SENSITIVE CIRCUIT MEANS

Original Filed Nov. 15, 1938

3 Sheets-Sheet 1

Fig. 1

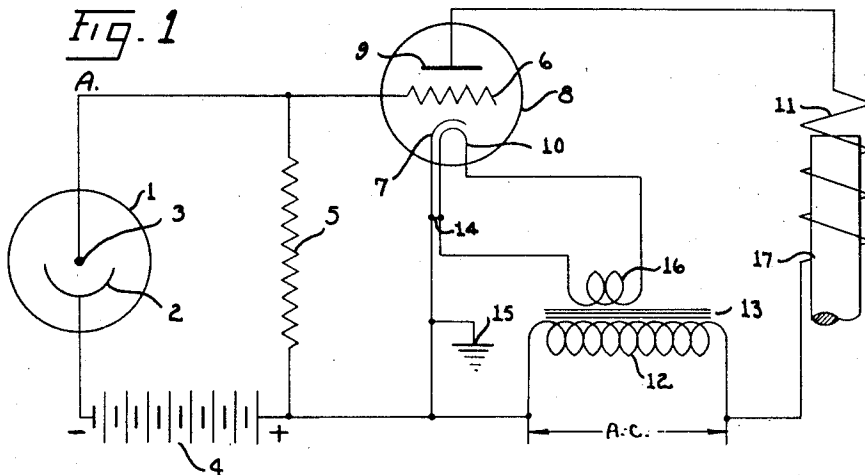
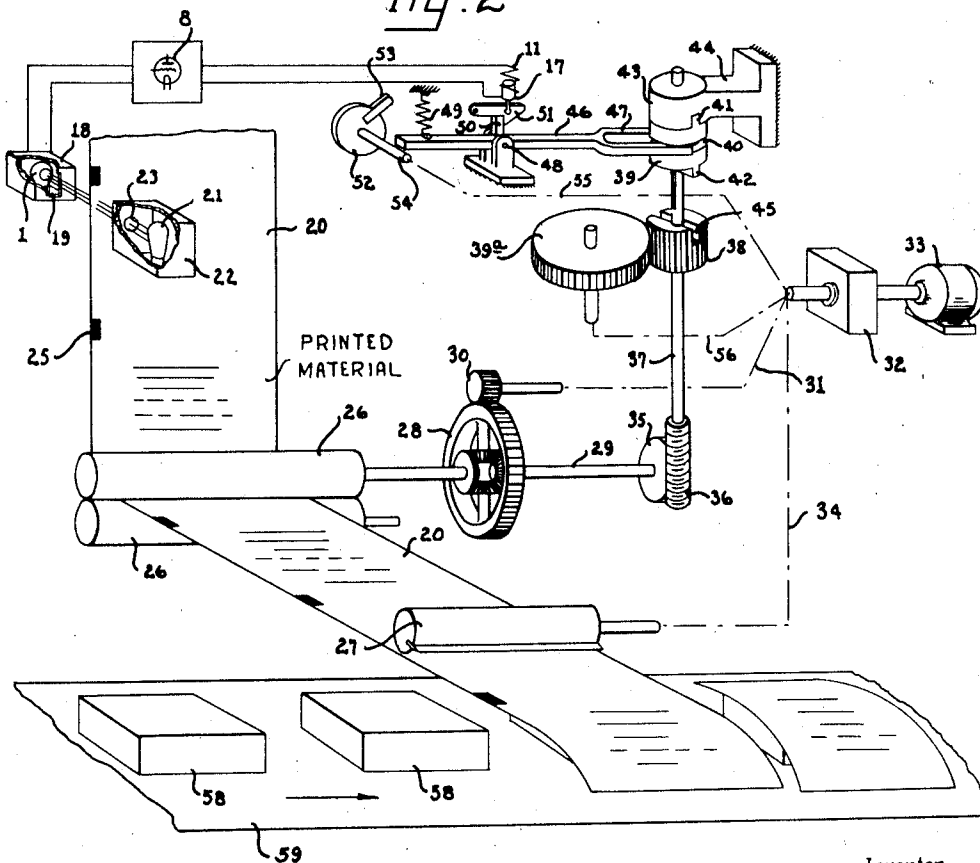


Fig. 2



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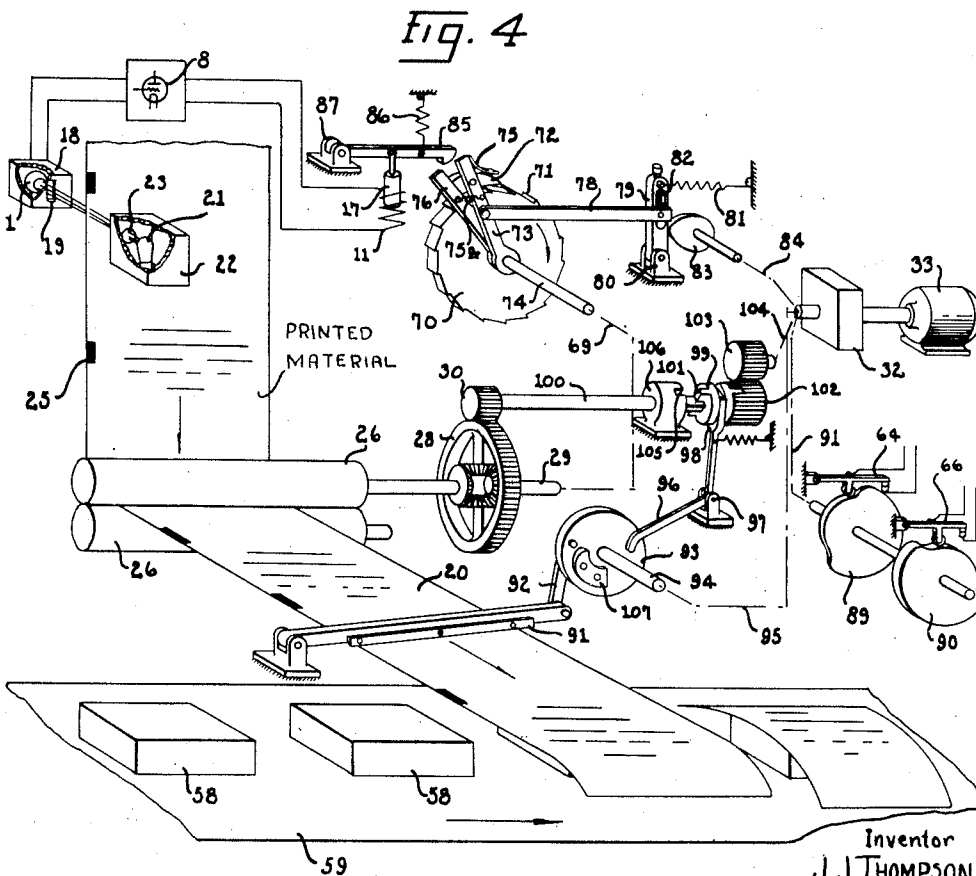
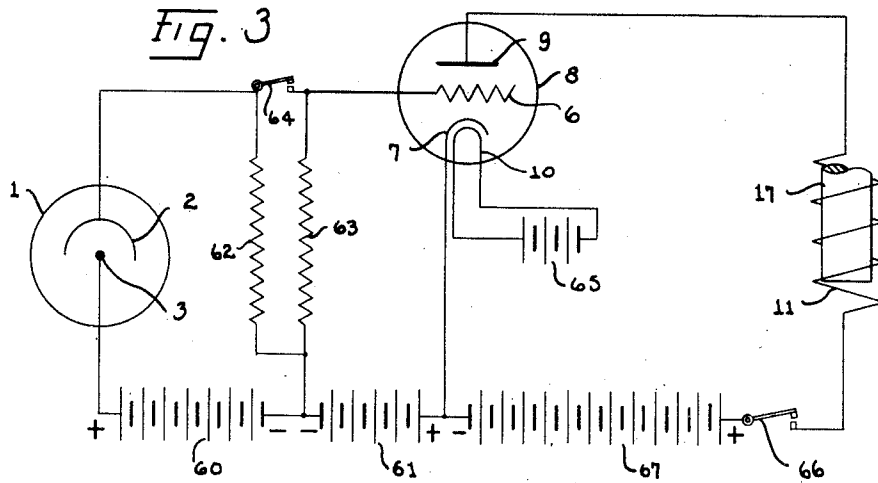
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LIGHT SENSITIVE CIRCUIT MEANS

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3 Sheets-Sheet 2



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LIGHT SENSITIVE CIRCUIT MEANS

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3 Sheets-Sheet 3

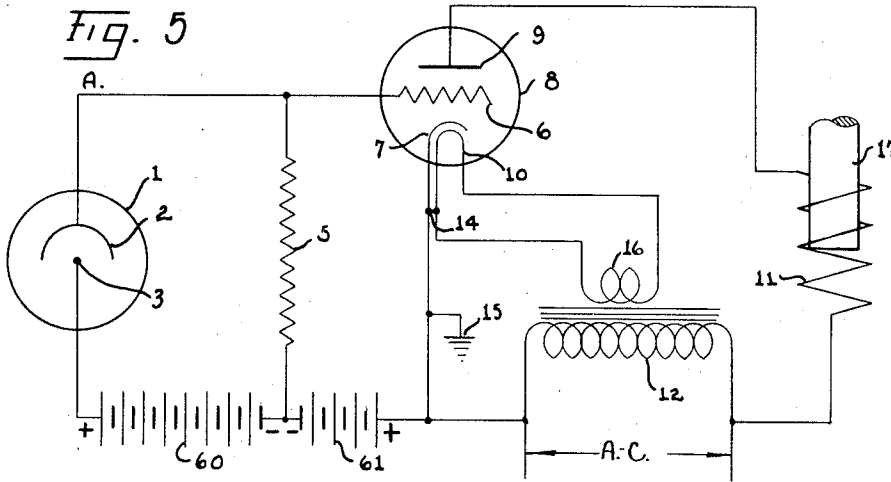
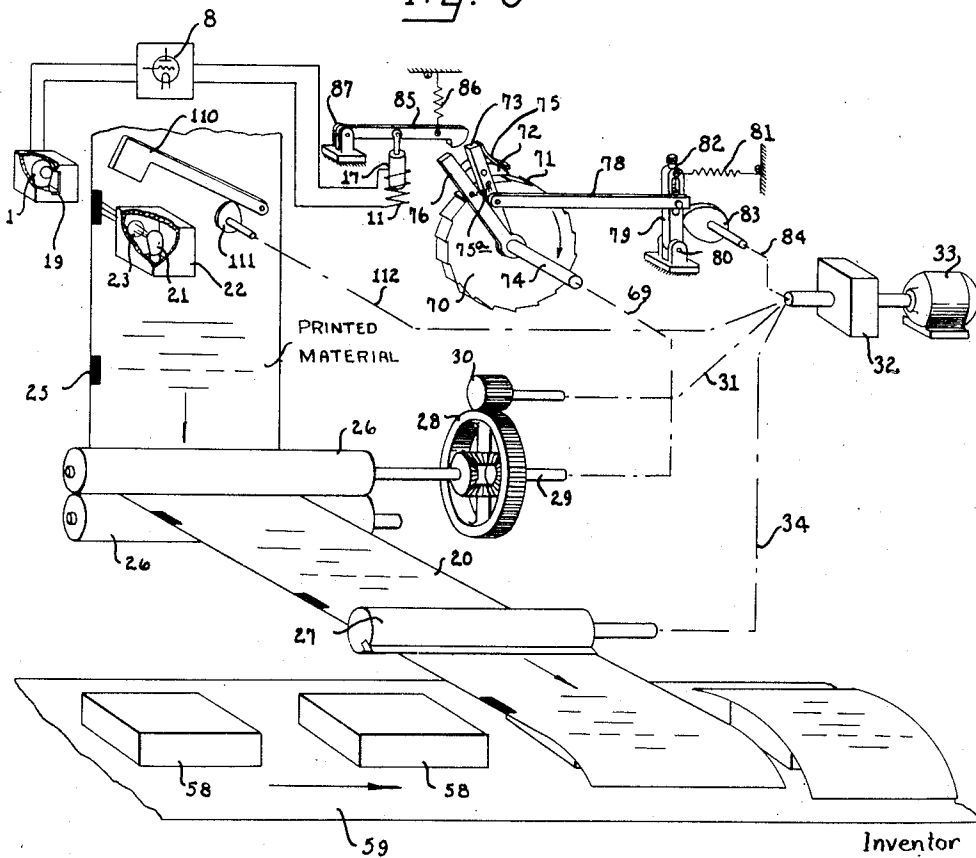


Fig. 6



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UNITED STATES PATENT OFFICE

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LIGHT SENSITIVE CIRCUIT MEANS

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4 Claims. (Cl. 250—41.5)

The present invention relates to combined paper-feeding and paper-cutting machines and, in particular, to the art of feeding paper at a constant rate to a cutter, thus insuring that each cut will be made at the same place relative to the printed matter on the paper.

When paper is being taken from a continuous roll and fed through gear-driven rolls to a knife, the line of severance does not always occur at the same position on the paper relative to the printed matter. Consequently, if the paper is used as wrapping material for a box containing, for example, foodstuffs, the printed material is not always positioned symmetrically on the box but actually may extend over the corners of the box, giving a bad appearance and decreased sales appeal. This change in position between the line of severance and the printed matter may be due to many reasons, of which perhaps the most important are slippage between the paper and the feed rolls, shrinkage or expansion of the paper due to climatic conditions, change of tension in the sheet, or difference in paper surface smoothness, etc., all of which may cause a considerable variation in the rate of paper feed.

Attempts have been made to overcome these difficulties in the past, and several of the installations utilize a photo-electric system which varies the rate of paper feed in a degree dependent upon the amount that a black spot on the paper becomes out of register with the light beam of the photo-electric control system. This variation in the paper feed velocity is effected by changing the speed of the feed rolls. Some of these arrangements have operated satisfactorily, but, in general, they involve great complication of apparatus including switches, control mechanism, etc., which tends to detract from their dependability of operation as well as necessitating a high cost of installation. As an example of one of these complications, it has been proposed in the photo-electric control unit to employ a vacuum tube amplifier between the photo-electric tube and the grid controlled rectifier. It has also been proposed to energize the rectifier with direct current and to insert in the plate circuit of the rectifier a time relay or other form of switch to open circuit the rectifier after correction of the feed roll speed has been attained.

The primary object of the present invention is to provide an improved and simplified system of correcting the speed of the rolls for feeding paper to a cutter to make up for the change in length of paper due to whatever cause.

Another object is to provide an improved photo-

to-electric control unit, particularly a system which employs the minimum number of tubes and is also adapted to be energized in such a manner that no timing relays or other open circuiting switches need be employed in order to de-energize the rectifier tube after the feed roll speed correction has been made. In carrying out this last-named object, the invention provides a photo-electric tube which operates directly into a gas-filled grid-controlled rectifier and the plate circuit of the latter is energized by alternating current.

Other objects and features will be apparent as the specification is perused in connection with the accompanying drawings, in which—

Figure 1 shows a circuit diagram of a photo-electric tube system, in which the grid controlled rectifier is energized whenever a black spot intercepts the light beam which impinges on the photo-electric tube;

Figure 2 is a diagrammatic showing of a combined electrical and mechanical system including gearing, etc., which advantageously employs the photo-electric tube unit illustrated in Figure 1;

Figure 3 diagrammatically illustrates a photo-electric tube control system, in which the grid controlled rectifier is energized whenever a light spot intercepts the light which impinges on the photo-tube;

Figure 4 shows a combined photo-electric tube control system and a mechanical arrangement which advantageously employs the system shown in Figure 3;

Figure 5 shows still another photo-electric tube control system, in which the grid controlled rectifier is energized whenever a light spot intercepts the light beam impinging on the photo-electric tube. This circuit differs from the circuit shown in Figure 3 in several respects, particularly in the manner in which plate circuit of the grid controlled rectifier is energized; and

Figure 6 illustrates a combined photo-electric tube control unit and mechanical arrangement which may advantageously employ the circuit shown in Figure 5.

Referring more particularly to Figure 1, numeral 1 designates the bulb of a photo-tube which contains a light sensitive cathode 2 and a rod-like anode 3. The bulb is preferably filled with an inert gas such as helium or other ionizable material, to provide sufficient ionization therein at the operating potentials. A tube of this character is known on the market as the PJ-23. The energizing potential is preferably ob-

tained from a direct current source 4, the negative terminal of which is connected to the light sensitive cathode 2. The positive side of the battery is connected through a resistor 5 to the anode of the photo-tube. This resistor provides a potential drop which is applied between the grid 6 and the cathode 7 of an electrostatically controlled rectifying tube or thyatron 8 which also contains an anode 9 and filament 10 for heating the cathode 7. This rectifier contains an ionizable medium and, when the grid is charged to the proper positive or less negative potential, an arc or a glow discharge takes place between the anode and the cathode. A tube which has been found to operate satisfactorily for this purpose is known on the market as the FG-57.

The output circuit of the rectifier includes the plate 9 and is taken through an electromagnet coil 11 to one side of a source of alternating current voltage which is impressed across the primary 12 of a low frequency transformer 13. The cathode and the heater are connected together at 14 and connected to ground at 15 and also to the other side of the alternating current mains. The heater is energized through the secondary winding 16 of the transformer 13. It will be thus seen that I employ a direct current for energizing the photo-tube and an alternating current for energizing the plate circuit of the grid controlled rectifier or thyatron.

The operation of the circuit is practically self-evident from the drawings. When light impinges on the light sensitive cathode 2, the resistance across the tube decreases and that tends to make the point A more negative which, in turn, causes a negative bias or control voltage to be applied to the grid 6. Under these conditions, the thyatron will not become ionized and hence no current will pass through the coil 11, and the relay armature 17 will remain in its lower position. On the other hand, if the light beam were intercepted in any manner, the resistance of the photo-tube immediately increases and the point A tends to become less negative or more positive, thus impressing a positive potential on the grid 6 of the thyatron. The latter immediately ionizes during the positive half cycle of the alternating current source, causing an extremely large current to flow through the coil 11, which immediately attracts its armature 17 upwardly.

As shown in Figure 2, the photo-tube 1 is preferably housed in a box 18 which is provided with a slit 19 for receiving light. The slitted box is preferably positioned at a different side of the paper roll 20 from the lamp 21 which is also contained in a box 22 provided with a lens opening 23. It will be understood that the photo-tube, the light source and any optical system provided in connection therewith may be conveniently included in a scanning head located back of the feeding rolls or other convenient place. The scanning head is on an adjustable frame so that it can be moved to suit the location of the spot 25, and to and from the paper to obtain the best focus. A number of these spots 25 are provided preferably along one edge of the paper 20 and all equidistantly spaced, as indicated on the drawings. The spots preferably are of a black color. The paper is fed through the feed rolls 26 to a rotary knife 27. The feed rolls obtain their power through a planetary gear 28 of the type which has a stationary or reaction member 29 and which is driven by a pinion 30. The function of the reaction member 29 will be described hereinafter. The pinion 30 is driven through a

shaft indicated by the dot-dash lines 31 a to a box of reduction gears 32 by a motor 33. The rotary knife 27 is also driven through suitable gearing indicated by the dot-dash line 34 and the gearing 32 by the same motor 33. As pointed out hereinbefore, due to certain irregularities of the paper or speed of the rolls, it is necessary to adjust the speed of the rolls from time to time so that the knife 27 will cut the paper along a severance line determined by the position of the printing on the paper. This adjustment in feeding roll speed is brought about by the apparatus which is about to be described, and is, in turn, controlled by the photo-tube 1.

In order to effect a change in the speed of the rolls, while they are being continuously driven by the gears 28, 30, it is necessary to rotate the reaction member 29 either in one direction or the other, depending upon whether the rolls need to be speeded up or retarded to take care of the irregularities in the paper. The rotational effect on the shaft 29 is obtained through a gear 35 which meshes with a worm gear 36 driven in turn by a shaft 37. This shaft is rotated through a slotted pinion 38 driven by a gear 39a when the slotted pinion is rigidly affixed to the shaft, as will be described hereinafter. This pinion normally idles on the shaft due to the turning effect of the gear 39a until the moment arises for the shaft to turn, as determined by the need for adjustment in the speed of the rolls.

The mechanism by which the slotted pinion 38 is made fast to the shaft 37, so as to cause rotation of the shaft, will now be described. Keyed to the upper end (as shown) of the shaft 37, there is a clutch 39 having a peripheral groove at the middle point and provided at the upper and lower surfaces with radially extending keys 41, 42 respectively. The key 41 is adapted to fit into a radial slot cut into the hub 43 of a hanger 44. The lower key 42 is adapted to fit into the slot 45 of the pinion 38. The clutch 40 is adapted to slide up and down along the shaft to which it is keyed and, when the clutch is in its lower position so that the key 42 engages the slot 45, the clutch is adapted to rotate with the pinion 38, thus causing the shaft 37 to rotate. For moving the clutch along the shaft, there is provided a bar 46 which has a bifurcated end, the furcations 47 of which straddle the clutch and loosely fit within the peripheral groove 40. The bar is pivoted at 48 and is mechanically biased by a tension spring 49.

Secured to the bar, directly over the pivot point, there is an upstanding member 50 which cooperates with a latch 51, to which is secured the movable core 17 of the electro-magnet 11 referred to in connection with Figure 1. There is a wheel 52 provided with a radially extending pin 53 which is adapted to strike the lefthand end of the bar 46 during each revolution of the shaft 54. This shaft is driven by shaftage indicated by dot-dash lines 55 connected through the gearing 32 to the motor 33. The driving gear 39 is likewise driven through shaftage 56 by the motor. The coil 11 is connected in the output circuit of the amplifier 8 as indicated in Figure 1 and the latter, in turn, is connected to the photo-tube 1.

Operation of Figures 1 and 2

When the paper comes through the rolls 26 and is thereafter cut into lengths by the knife 27, the severed strips are laid across the boxes 58 which contain foodstuffs, etc., and which are

presented by a moving belt 59 past the paper-severing machine to a machine (not shown) which wraps the paper about each box. Since the latter operates automatically, it has been found on occasion that when the wrapping paper has printed matter thereon, the printed material does not appear symmetrically and in its proper position on the box. This is due to the fact that the paper has not been severed at the proper place and may be caused by many reasons peculiar to the characteristics of the paper. A need, therefore, arises for adjusting this severance point or position, and this adjustment most conveniently is obtained through a control of the speed of the feed rolls. The proper speed of the paper feed is determined according to the present invention by the use of a series of black spots 25 equi-distantly spaced along one edge of the paper. Whenever a black spot intercepts the light beam emanating from the lens 23, the internal resistance of the photo-tube 1 is increased, and this tends to drive the grid 6 of the thyatron more positive and to produce ionization within the tube 8 during the positive half cycle of the alternating current source. Thus, the coil 11 is strongly energized and pulls up its core 17 together with the latch 51, thus releasing the vertical projection 50 and permitting the spring 48 to slide the clutch 39 downwardly until it engages the pinion 38. The latter is, therefore, rotationally secured to the shaft 37 and causes the latter to rotate due to the driving effect of the gear 39a. The rotating effect of the shaft 37 is communicated to the shaft 29 which, in turn, rotates the reaction member of the planetary or differential gear mechanism 28, thereby causing a slight acceleration or retardation of the speed with which the rolls 26 are driven by the pinion 39.

While the mechanism described up to this point is adapted to introduce either an under-drive or an over-drive of the feed roll when the black spot intercepts the light beam, for practical reasons it has been found desirable to adjust the mechanism including the position of the black spot with respect to the light beam such that each adjustment of the feed roll speed is in the form of a retardation rather than acceleration. Consequently, the reaction member is rotated in only one direction. In order to cause this retardation, the positional relation between the black spot and the light beam is such that the black spot intercepts the light beam at an instant of time which is too early as determined by the periodicity of the continuously moving parts of the mechanism. Thus, the light beam is intercepted by the black spot which is deliberately set to arrive too early, and consequently the mechanism is operated to adjust the planetary gear system until after a few adjustments, it will be found that the black spot has arrived at its proper instant of time. Under these conditions, the rotary knife 27 will sever the paper at the proper position.

In order that no further adjustment of the feed roll speed will be made in case the black spot arrives at the proper time in front of the light beam, I have provided the rotating pin mechanism 53, the rotations of which are so timed by proper gearing, etc., that the pin will strike the bar 46 at the same instant of time that the black spot should be intercepting the light beam when the speed of the feed rolls is correct. As stated hereinbefore, every time the pin strikes the bar, the clutch 39 is disengaged

from the pinion 38 so that the latter cannot rotate the shaft 37. It is clear that the time during which the pin does not physically contact with the bar 46 is a time interval during which an adjustment of feed roll speed can be made by the black spot interception of the light beam. The closer that the pin 53 comes to the bar 46, the less will be this time interval until, when the pin strikes the bar and the black spot is in line with the light beam, no adjustment can be made or need be made.

From the foregoing, it is, therefore, clear that I have described a very practical system in which a photo-electric control unit always operates to back up the feed, and the amount of retardation is controlled by whether the black spot arrives early or late, as determined by the instant that the pin 53 strikes the bar 46. It is obvious that the position of the pin 53, in its rotating path, can be adjusted to give a normal or average over-drive, if desired.

It is apparent that as much or as little adjustment may be provided by this mechanism due to the rotary character of the adjusting elements 38, 39, so that the black spots may be considerably out of register and readily brought into register during the passage of only a few severed strips. Thus no time is lost in threading the paper to line up the black spots as may be necessary in other forms of machines, since it is only necessary to start the paper through the rolls and start the machine.

In Figures 3 and 4 I have shown another form of photo-electric control unit and feed roll speed adjustment mechanism. The control unit is so arranged that the thyatron is energized when a white spot intercepts the light beam instead of a black spot as in Figure 1. This unit is constituted of a photo-tube 1, preferably of the type described in connection with Figure 1. The photo-tube feeds into an electrostatically controlled amplifier which preferably is a thyatron similar to that described in connection with Figure 1. The anode of the photo-tube is connected through a pair of batteries 60, 61, the negative terminals of which are connected together and connected through a pair of parallel resistances 62, 63, to the light sensitive cathode 2, and grid 6 of the thyatron. The positive terminal of the battery 60 is connected with the anode of the photo-tube and the positive terminal of the battery 61 is connected to the cathode of the thyatron.

In the grid circuit of the thyatron there is a switch 64 positioned between two separate terminals of the resistors 62, 63, the purpose of which will be described hereinafter. The cathode of the thyatron is heated by a filament 10 preferably energized from a direct current source of potential 65. The plate circuit of the thyatron includes the operating coil 11 of the electromagnet 17, similar to Figure 1 and in addition includes a switch 66 which is connected through the battery 67 to the cathode.

A mechanism which will be described hereafter, opens and closes the switches 64, 66 in synchronism. Assuming that the switches have been closed momentarily, and that a white spot (i. e., the absence of a black spot) intercepts the light beam, the light sensitive cathode 2 is activated which in effect reduces the resistance of the photo-tube. Current from the battery 60 flows through the tube and through the resistors 62, 63 in parallel. The drop in potential across these combined resistances is such as to drive

the grid 6 less negative or more positive and causes an arc or glow to flow in the tube 8 due to the ionizing effect of the potential 87. The plate current flowing through coil 11 pulls the core 17 downwardly.

However, when a white spot is passing in front of the light beam and it so happens that the switch 64 is open at the moment, the grid circuit of the thyatron is also opened, so that the latter will not be ionized. Consequently in order that the electro-magnet 11 shall operate, it is necessary that the switches 64 and 66 be closed for a light spot interception or rather, to have no black spot interposed between the photo-tube and its light source.

As in the case of Figures 1 and 2, the electro-magnet 11 serves to adjust, preferably to retard the speed of the paper feed rolls 26. The mechanism by which this is accomplished, now to be described, is shown in Figure 4. Whenever an element appears in this figure corresponding to a similar element in Figure 2 it will be given the same reference character. This retardation effect is brought about by a planetary or differential gearing 28, having a reaction member 29. The reaction member is coupled through shaft-
age 69 (indicated by dot-dash lines) driven by a ratchet wheel 70. The teeth 71 on the ratchet are so arranged that the wheel turns clock-wise as indicated in Figure 4. For rotating the ratchet wheel a pawl 72 is provided which is pivoted on the end of an arm 73 carried by the shaft 74. There is a spring 75 tending to hold the pawl 72 in one of the ratchet teeth. An arm 76, also pivoted on the shaft 74 is connected to the arm 73 and has for its purpose to hold the pawl 72 out of engagement with the teeth 71. This is accomplished by permitting arm 76 to abut against the rear flat surface of the pawl, this surface being cut at such an angle that when contact with the arm 76 is made, the pawl 72 is rotated slightly on its pivot to remove its biting end from the teeth 71 against the action of the spring 75. This is the position shown in Figure 4. However, when the two arms 73 and 76 are angularly displaced with respect to one another, the arm 73 which carries the pawl moves the rear surface of the latter away from the arm 76, permitting spring 75 to force the pawl in to the teeth.

The arm 73 is given a reciprocating motion through the bar in any suitable manner. The mechanism shown for this purpose consists of an arm upright 79 which is adapted to swing in a vertical plane about the pivot 80 and is mechanically biased by tension spring 81. This arm is preferably provided with a vertical adjustment for the bar 78 as indicated at 82. The arm 79 is arranged to ride along the outside surface of a cam 83 which is continually rotated by a shaft 84 connected back to the gear box 32. Consequently, as the cam 83 is rotated the bar 78 reciprocates in a horizontal direction and thus gives the arm 73 an angular motion which in turn transmits a similar motion to the arm 76 through the springs 75a. In as much as the arm 76 abuts the rear surface of the pawl 72, the latter is kept out of engagement with the teeth 71, and the ratchet wheel 70 does not turn and no adjusting effect is transmitted to the reaction member 29. However, a mechanism which will now be described is provided for preventing the arm 76 from following the arm 73 in its reciprocating movement, so that the latter will cause the pawl to engage the teeth and thereby move the ratchet

wheel. This mechanism consists of a latch 85 which is spring biased at 86 and is adapted to move on a pivot 87. The latch is secured to the core 17 of the electro-magnet 11 referred to here-
inbefore. It is apparent that as the coil 11 is energized the core 17 is pulled downwardly causing the latch 85 to engage the arm 76 and thereby preventing the latter from following the arm 73 in its angular movement. Thus when the coil 11 is energized, the pawl 72 no longer abuts the arm 76 and is pressed downwardly against the teeth 71 by the spring 75.

As pointed out herebefore, the thyatron 8 and coil 11 become energized when a white spot passes in front of the light beam. Since this white spot really constitutes the entire length of the paper margin between the black spots, some means must be provided to prevent a continuous energization of the coil 11 and therefore a continuous operation of the adjustment mechanism as initiated by rotation of the ratchet wheel. While various means for effecting this purpose will occur to those skilled in the art, I prefer to employ the switches 64, 66 (Figure 3) and shown again in the lower right hand corner of Figure 4. These switches are preferably of the pivoted type and are provided with rolls which bear against the surfaces of a pair of cams 89, 90 respectively. The cams are rotated by a shaft 91 connected to the gear box 32. The cam surfaces are so designed that each switch is closed over a considerable period of time per revolution of the cam. However, the cams are mounted on their common shaft in such a manner that the switches are closed in synchronism only for a short interval of time. It is apparent that by employing two reversely arranged cams mounted on a common shaft, as shown in Figure 4, the time period over which the smaller diameter portion of each cam permits the switches 64, 66 to close can be made extremely short. Due to the reverse arrangement of the cams, the smaller diameter portion of each cam can extend over a substantial part of the cam periphery, thus simplifying the design and manufacture of the cams without affecting the speed with which the switches are opened and closed, and vice versa. The input and output circuit of the tube 8 are thus rendered operative for only a short time interval during which the tube will respond to current impulses from the light sensitive device. Consequently, it is only during this test period, i. e., when the switches close synchronously that the coil 11 can be energized and ratchet wheel 70 rotated in response to a need for adjustment of the speed of the paper feed roll by operation of the reaction member 29. The fact that a light spot does intercept the light beam when the switches 64 and 66 are closed in unison shows that the black spot is out of register, and the paper feed necessitates adjustment. It is apparent that when the speed of the roll is correct so that the black spot intercepts the light beam during the instant of time the switches 64, 66 close, the thyatron 8, will not be energized on account of the manner in which the electrical connections are made. As in the case of the systems shown in Figure 2 it is desirable to initially adjust the speed of the rolls 26 to give a slight over-drive so that the photo-electric control unit is also tending to back up or retard the speed of the rolls until the proper speed is obtained depending on the expansion or contracting slippage of the paper.

In this figure I have shown a reciprocating knife 91 rather than a rotary element. This knife

is actuated through a pitman 92, pivotally connected to a rotary crank 93. The latter is rotated through a shaft 94 by shaftage 95 which goes back to the gear box 32. I have also illustrated an optional mechanism by which the feed rolls are 5 instantaneously stopped periodically during the time that the knife 91 is severing the paper. This mechanism may take the form of a bell crank lever 96 pivoted at 97 and having an upper arm which terminates in a bifurcated portion. The 10 furcations are contained within a groove on a clutch 99 which is keyed to a shaft 100.

The clutch has on its opposite faces, radially extending keys 101, the right-hand one of which 15 engages the slot in gear 102. This gear normally idles on the shaft and is rotated by pinion 103 through a shaft 104. The left-hand key 101 is adapted to engage the slot 105 in a stationary bearing member 106. The shaft 100 carries the pinion 30 which drives the differential 28 as explained hereinbefore. There is provided on the 20 rotary crank 93 a cam 107, the outer surface of which is adapted to engage the lower end of bell crank lever 96. It is apparent that as the member 93 is rotated by the shaft 94 in order to reciprocate the knife 91, during the paper severing operation, the cam 107 engages the lever 96 and 25 causes the clutch 99 to move along the shaft 100 to engage with the slot 105 and to disengage with the slot 102. Thus no rotating effect is exerted on the shaft 100 by the gear 102 but instead, a brake effect is produced by the meshing of the key 99 with the slot 105 and the stationery member 106. In as much as the feed rolls are thus 35 stopped during the severing operation, the paper at the back of the knife does not pile up and form a loop.

Still another form of photo-control system and feed roll adjusting mechanism is shown in Figures 5 and 6. In Figure 5, the circuit is somewhat 40 similar to that shown and described in Figure 1 except that the photo-tube is reversed and some changes are made in the potentials applied to the photo-tube and to the grid circuit of the thyatron. These potentials, similar to those described in connection with Figure 3, are obtained from a 45 pair of batteries 60, 61. The negative terminals of the batteries are connected together and to the grid biasing resistance 5. The positive terminal of battery 60 is connected to anode 3 of the photo-tube and the positive terminal of battery 61 is connected to the cathode thyatron.

This system becomes operative when a light spot intercepts the light beam. Under these conditions the resistances of the photo-tube will decrease, permitting more current to flow from the 50 battery 60 through the tube and through the resistor 5 and tending to make the point A more positive. The increased voltage drop through 5 overcomes or diminishes the negative potential normally applied to the grid 6 by the battery 61, thus causing the grid to become less negative or more positive. Under these conditions an arc or glow discharge is produced in the thyatron and the coil 11 is energized to attract its armature 55 core 17. The mechanism shown in Figure 6 operates for the most part similar to that described in connection with Figure 4 except that a rotary knife 27 is provided. The time during which a test can be made to determine whether or not a light spot is opposite the light beam and have the 60 thyatron operate to adjust the speed control mechanism is determined by a reciprocating mask 110. This mask serves to shield the photo-electric tube from the light except at predetermined 75

instants of time. The mask may be given a reciprocating angular movement in any suitable manner and as illustrated, is arranged to engage the surface of a cam 111 which is continually rotated 5 by a shaft 112 (indicated by dot-dash lines) connected to the gear box 32. In case the paper is out of register at the time that the mask is in its elevated position, that is, in a position to expose the photo-tube, a light spot will intercept the light beam instead of a black spot. This will 10 cause the thyatron 8 to become energized and will move the electro-magnet 17 into the coil 11, causing the ratchet wheel 70 to rotate and thereby move the reaction member 29 of the planetary or differential gear system. On the other hand if a black spot intercepts a light beam at the time the mask exposes the photo-tube, the 15 thyatron will not operate, due to the manner in which it is connected and no adjustment will be made. As in the case of the other figures, it is desirable that an over-drive be deliberately introduced so that the photo-electric control unit will tend continually to retard the speed of the paper feed rolls, until a condition is reached in 20 which the black spots are in proper register with the light beam.

While I have shown and described different forms of feed roll adjustment mechanism for operating with different but specific types of photo-electric control units, it is obvious that other combinations may be devised, interchanging the adjustment mechanisms and the control units, depending on whether it is desired to operate the mechanism by the registry of a black or white spot with the light beam. Each control unit and its specific adjusting mechanism offer certain advantages. For example, in the circuit shown in Figures 1 and 5 which employ a mechanical arrangement for limiting the test period to an almost instantaneous period of time, an electrical arrangement is provided in the thyatron circuit for preventing continuous ionization. This interrupting effect is brought about by the use of 45 alternating current plate circuit energization which automatically stops the arc at the end of each positive half cycle of current. On the other hand, in Figure 3, in which direct current is employed for plate circuit energization, the arc is periodically interrupted by a mechanically operated switch which lends itself admirably to the switch mechanism employed in the grid circuit of the thyatron. However, in all cases, and regardless of the manner in which the time period is determined during which the position of the white or dark spot is tested, the period is of very short duration. Consequently, extreme accuracy can be obtained in adjusting the planetary gear system or any other control speed mechanism in order to vary the feed roll speed and thereby offset the slippage, expansion, contraction or any other irregularity in the paper which might cause the severing line to be improperly positioned with respect to the printing on the paper.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims and the invention.

This application is a division of my application Ser. No. 240,595, filed November 15, 1938.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In combination, an amplifier having grid and plate circuits, a light sensitive device connected to said grid circuit, a relay in said plate

circuit, direct current means for energizing the light sensitive device and for biasing the grid of the amplifier, direct current means for energizing said plate circuit, a control relay in said plate circuit, and a switch mechanism for periodically interrupting said grid and plate circuits.

2. In combination, a photo-tube having a cathode and an anode, an amplifier having a cathode, grid and plate, the cathode of the photo-tube being connected through a switch to the grid of the amplifier and the anode of the photo-tube being connected through a source of direct current potential to the cathode of the amplifier, a pair of resistors connected between the grid and cathode of the amplifier on opposite sides of said switch, whereby when the switch is opened only one resistor is effectively in shunt to the grid-cathode circuit of the amplifier and when the switch is closed two resistors in parallel are effectively in shunt to the grid cathode circuit of the amplifier, a control relay, and a source of potential connected between the plate and cathode of the amplifier.

3. In combination, a photo-tube having a cathode and an anode, an amplifier containing an ionizable medium and having a cathode, grid and plate, the cathode of the photo-tube being connected through a switch to the grid of the amplifier, the anode of the photo-tube being connected through a source of direct current potential to the cathode of the amplifier, a pair of re-

sistors connected between the grid and cathode of the amplifier on opposite sides of said switch, whereby when the switch is opened only one resistor is effectively in shunt to the grid-cathode circuit of the amplifier and when the switch is closed two resistors in parallel are effectively in shunt to the grid-cathode circuit of the amplifier, a control relay, and a source of direct current potential connected between the plate and cathode of the amplifier, means for periodically interrupting the plate circuit of the amplifier, and means for actuating said switch in synchronism with the interruptions of said plate circuit.

4. In combination, an amplifier having grid and plate circuits, a light-sensitive device connected to said grid circuit, a relay in said plate circuit, direct current means for energizing the light-sensitive device and for biasing the grid of the amplifier, direct current means for energizing said plate circuit, a control relay in said plate circuit, and a switch mechanism for periodically opening and closing said grid and plate circuits, said mechanism comprising a pair of cams, a common shaft therefor, said cams having substantially similar effective contours but reversely mounted on the shaft and so arranged that when the shaft is rotated the corresponding portions of the effective contours of the cams come into line and said mechanism is operated simultaneously to close the grid and plate circuits.

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