

July 22, 1941.

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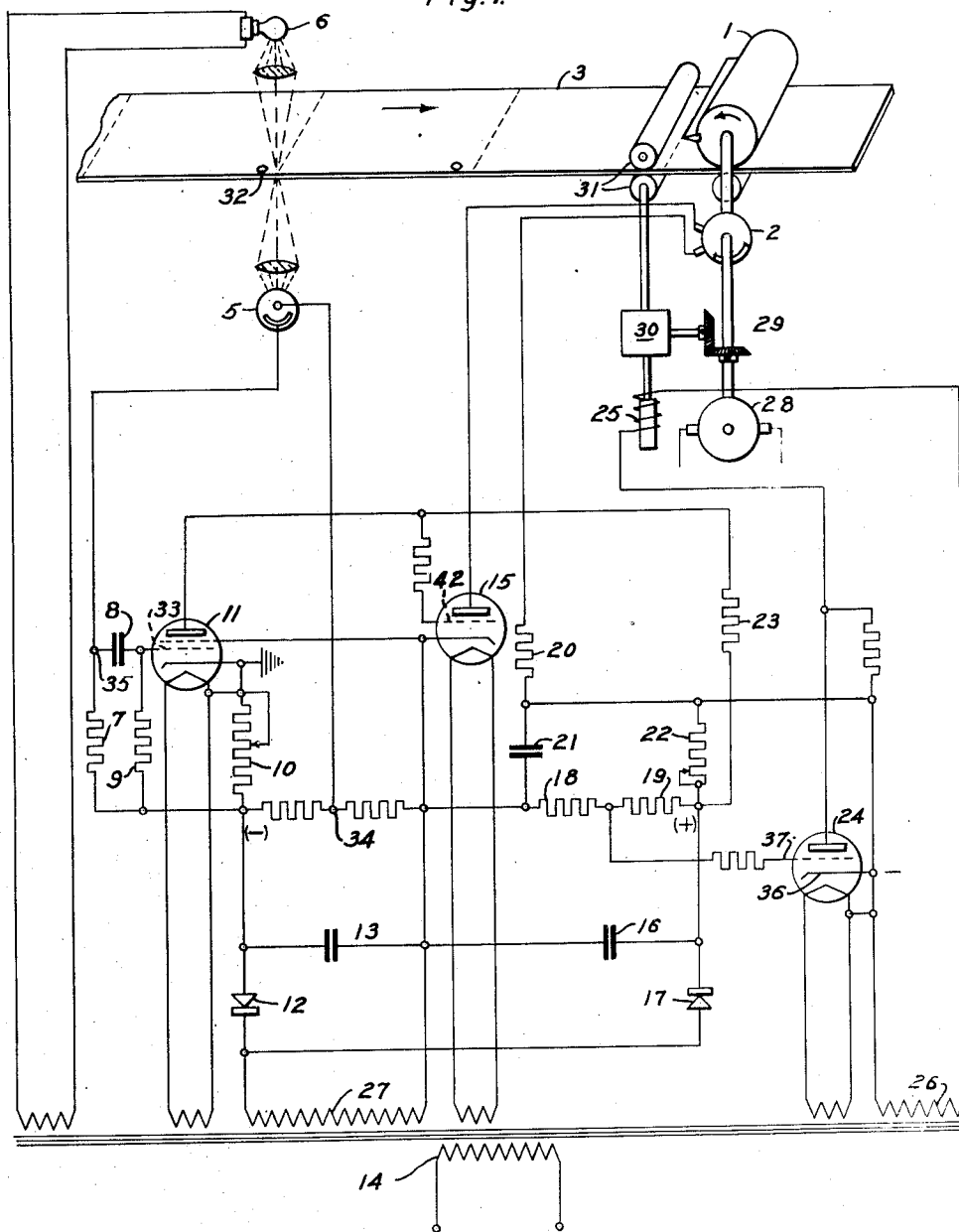
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REGISTER CONTROL FOR PAPER CUTTING MACHINES

Filed June 23, 1939

2 Sheets-Sheet 1

Fig. 1.



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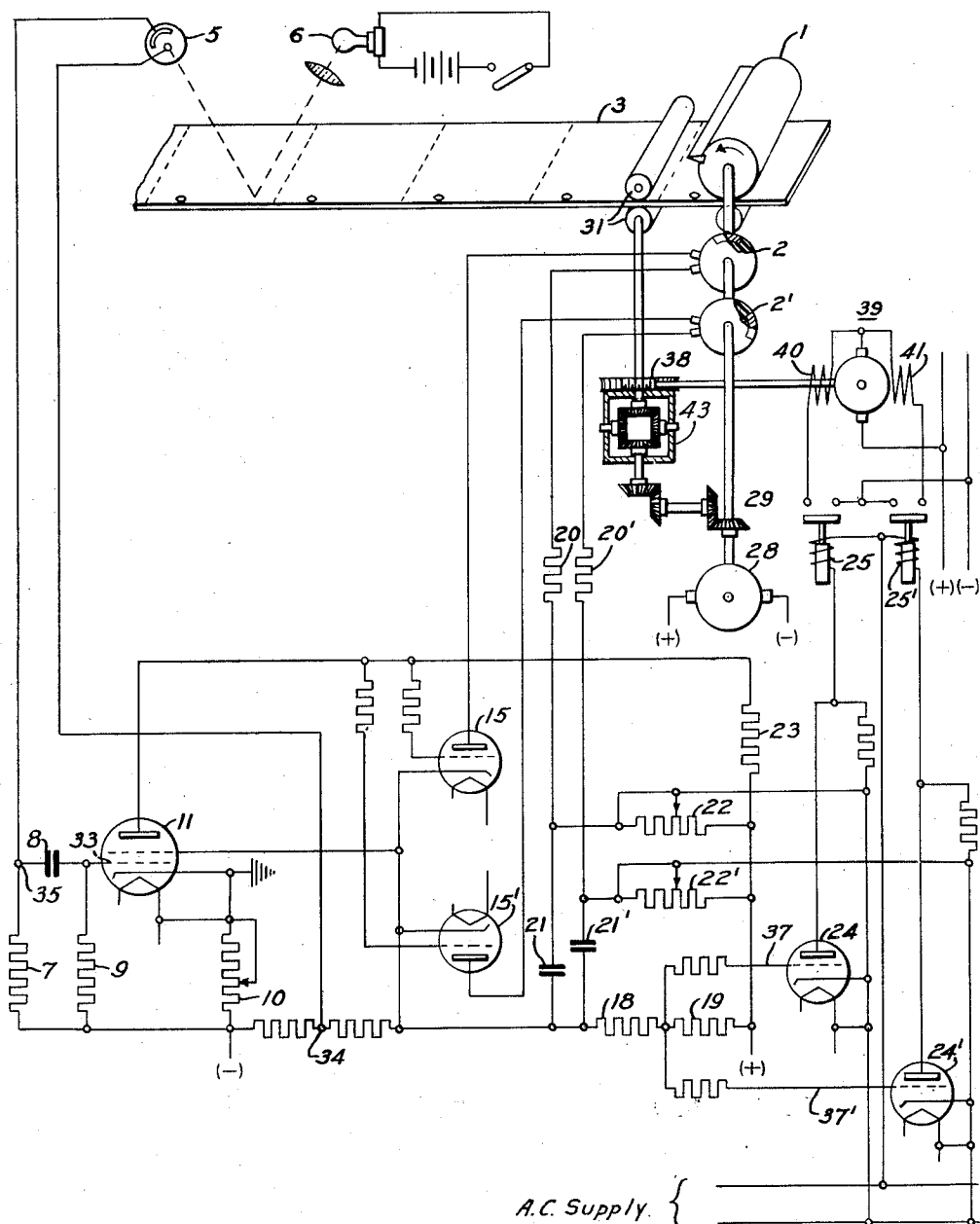
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2 Sheets-Sheet 2

Fig. 2.



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REGISTER CONTROL FOR PAPER CUTTING MACHINES

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9 Claims. (Cl. 164-68)

My invention relates to a photo-electric register control which is particularly adapted to synchronize a travelling sheet and a rotating cutter in a paper cutting machine, or, in general, to synchronize any two rotatable elements.

In the past, photo-tube register controls have been used in paper cutting machines and the usual practice has been to have the photo-tube control the grid of an amplifier or grid glow tube, and the amplifier tube control the grid circuit of a gas-filled discharge tube, the latter of which is connected to a direct-current source. A selector switch, geared to the cutter, will then operate in the grid circuit of the discharge tube so that this tube can only break down and operate the relay controlling the speed changing device if the photo-tube impulse caused by the printed spot on the paper or web occurs when the selector switch is closed. When this happens, the discharge tube breaks down or discharges and thus energizes the speed changing relay. This relay then controls a mechanism which is adapted to change the relative position between the paper and cutter knife so as to keep the proper relation between the cutter and the printed design on the paper. The discharge tube is energized from a direct-current source and for this reason it is necessary to introduce a time delay relay which opens the anode circuit and deenergizes the relay after a predetermined time interval. The main disadvantage of this arrangement is that the selector switch is connected in the grid circuit of the discharge tube. Since this circuit usually has an impedance of approximately 1,000,000 ohms, it has been found that in practice it is difficult to design a selector switch with sufficient insulating resistance so that reliable operation is obtained. Furthermore, the capacitance between the leads connected to the selector switch affects the operation of the register control equipment.

Another disadvantage of this circuit and other similar circuits used in the past is that the time during which the relay remains closed, and consequently the time during which the position of the paper is being corrected, is always constant, whereas the ideal characteristic would be to have the time of relay closure proportional to the deviation of the paper from its correct normal position.

An object of my invention is to overcome the above named disadvantages and to provide a photo-electric register control which is simple, inexpensive and reliable in operation.

Another object of my invention is to provide

a photo-electric register control in which the selector switch is not located in the grid circuit of a discharge tube but is, instead, connected in the circuit of the principal electrodes of such tube.

Another object of my invention is to provide a register control for a paper cutting machine or the like in which the time during which the paper speed is being corrected is a direct function of the amount of deviation of the paper from its correct normal position.

Other objects and advantages will become more apparent from a study of the following specification when considered in conjunction with the accompanying drawings, in which:

Figure 1 is a diagrammatic showing of a paper cutting machine embodying a photo-electric register one-way control in accordance with the principles of my invention; and

Fig. 2 is a modification of the control system shown in Fig. 1 involving a two-way control.

Referring more particularly to Figure 1, numeral 1 designates a rotatable cutter. Numeral 2 denotes a brush type of selector switch in which one of the elements thereof comprises a rotatable arcuate segment which is coupled, either directly or through suitable reduction gearing, to the cutter 1. For each complete revolution of the arcuate segment the paper should move a distance of the desired length of the finished sheet (as indicated by dotted lines). Numeral 3 denotes the web, paper or other sheet material which is being moved in the direction shown by the arrow. A photo-tube 5 in connection with a lamp 6 scans the paper. While the scanning shown embodies light transmitted through the paper it will be apparent that reflected light will be equally suitable. Preferably the paper is driven at a slightly greater speed than the cutter.

Through a well-known capacitor coupled circuit consisting of resistor 7, capacitor 8, and resistor 9, the grid 33 of the screen-grid type of amplifier tube 11 is controlled. Tube 11 is biased in a well-known manner by means of an adjustable resistor 10, the resistance value being adjusted to effect proper operation of tube 11.

A source of alternating current is applied across a primary 14 of a transformer, one of the secondaries 27 of which, together with rectifiers 12 and 17 and capacitors 13 and 16 form a well-known voltage doubler circuit which is effective to supply a relatively high voltage of direct current (in the neighborhood of 250 volts) at the terminals marked with the plus and minus signs.

Tube 15, which is a discharge type tube such as a Thyratron tube, has connected in its anode circuit a selector switch 2, a resistor 20, and a condenser 21. The condenser 21 is adapted to be charged to the potential across resistors 18 and 19. A variable resistor 22 and a resistor 23 are also provided in the circuit as shown. A second discharge tube 24 is connected in series with a relay coil 25 and a secondary winding 26 of the transformer.

The cutter 1 and the selector switch 2 are driven by driving motor 28. Driving motor 28 through bevel gears 29 and a speed changing device 30 also drives one, or both of a pair of rollers 31 which are adapted to frictionally drive the web or paper 3 which is compressed therebetween by springs or any suitable yieldable means (not shown). Numeral 32 denotes one of a plurality of spots or other markings appearing on the web or paper 3. Speed changer 30 may be of any conventional type, for example it may be a gear shift mechanism, a friction clutch, a differential mechanism, a pair of oppositely disposed contacting cone members driven by a shiftable belt, or other suitable mechanical speed changing means which serves to alter the speed of the rollers 31 with reference to the cutter 1. The rolls 31 feed the web or paper to the cutter both during the time that relay coil 25 is energized as well as when deenergized. The relay 25, when energized changes the speed relation between the cutter and the rolls 31.

The operation of the device is as follows: Let us assume that web or paper 3 is being fed into cutter 1 at a speed greater than that required for synchronous operation with regard to the cutter 1. A spot or mark 32 will block the passage of light from lamp 6 to photo-tube 5, therefore darkening photo-tube 5 and making the control grid 35 of tube 11 more negative. This fact will be readily seen by considering the positive potential point 34 and following the current therefrom through photo-tube 5 to point 35. When the photo-tube is illuminated, points 34 and 35 are at substantially the same positive potential. However, when photo-tube 5 is darkened, thereby greatly increasing its impedance, the voltage drop therethrough will be considerable, hence point 35 will assume a substantially more negative value as compared with point 34. The potential of control grid 33 varies substantially as that of point 35. As the potential of control grid 33 becomes more negative, the current through tube 11 decreases and momentarily drops to zero value. Hence control grid 42 will have impressed thereon a more positive potential than previously, thus causing break down of tube 15 to become conductive. As pointed out heretofore, the potential across condenser 21 is normally equal to the voltage across resistors 18 and 19, and therefore there is no voltage drop across resistor 20 inasmuch as there is no current flow therethrough. If contacts of the selector switch 2 are closed at any time when tube 15 has been made conducting as the result of the photo-tube impulse, condenser 21 will discharge through said tube through a path including resistor 20 and bridged contact members of the selector switch 2. This discharge period lasts only so long as the contact members of selector switch 2 remain closed. It will be readily seen, therefore, that if there is a substantial departure from synchronism of the paper speed and the cutter speed, tube 15 will break down just as the contact members of selector switch

2 begin to close. The period of closure of the contact members of the selector switch following the moment of break down of tube 15 will be at a maximum, that is, condenser 21 will have had sufficient time to completely discharge through tube 15 before the discharge circuit is interrupted by selector switch 2.

On the other hand, let us assume that the paper speed while abnormal, thus requiring correction, is not of a substantial abnormal value, hence requiring only a small, instead of a large correction. In this situation tube 15 will break down after the contact members of selector switch 2 have already been closed for a time. Hence the period during which the discharge takes place is shorter than the previously assumed situation because the contact members of the selector switch will open sooner after the break down of tube 15, hence allowing time for condenser 21 to discharge only partially instead of discharging completely.

During the charging period of condenser 21, the upper plate will be charged positively, thus tending to impose a positive potential on the cathode 36 of tube 24, while the lower plate will be charged negatively, thus tending to impose a negative potential on the control grid 37 of tube 24. When the condenser discharges through tube 15, therefore tending to reverse its initial polarity, the previously described positive potential will be removed from cathode 36 therefore tending to make it more negative and the previously described negative potential which is imposed on control grid 37 will be removed, therefore tending to make it more positive. This will effect a break down of tube 24, hence completing a circuit from a secondary 26 of the transformer, relay coil 25 and across the anode and cathode of tube 24.

If the discharge of condenser 21 had been only a partial one so that its decrease of voltage is small, the charging period thereafter required to restore the voltage to its initial value would be relatively short in time. On the other hand, if the discharge period of condenser 21 had been relatively long, therefore allowing sufficient time for complete discharge, the voltage decrease of the condenser would be greater, hence the time required for recharging the condenser back to its initial value would be longer. In view of these facts, it will be seen that the period during which tube 24 remains conducting, hence the period during which relay coil 25 remains energized, will be substantially directly proportional to the amount of deviation of the paper speed from its normal value for maintaining synchronism with the cutter. By making the correction of speed proportional to the amount of abnormality of the paper speed, it will be seen that hunting will be substantially minimized and more reliable speed control and, in turn, synchronism of the paper speed with the cutter speed is secured. The period required for fully charging condenser 21 may be made adjustable by varying the value of the resistance of resistor 22. For that reason resistor 22 is shown as variable. In other words, the greater the value of the resistance of resistor 22, the longer will be the time required for fully charging condenser 21 to the value of voltage across resistors 18 and 19.

The main disadvantage of the control system shown in Fig. 1 is that the control is "one-way," that is, the paper must be deliberately run at a speed which is greater than that necessary for maintaining synchronism between the paper and

the cutter. With such an arrangement, the paper speed must be periodically slowed down by the control so as to maintain synchronism between the paper and cutter.

Fig. 2 shows a modification of the control scheme embodying the principles of my invention which overcomes the disadvantages of the control scheme shown in Fig. 1. The control scheme in Fig. 2 provides a "two-way" correction, that is, it corrects the paper speed either if it is too fast or if it is too slow for synchronous operation with respect to the cutter.

Many of the elements in Fig. 2 correspond exactly to those in Fig. 1 and are, therefore, denoted by the same reference numerals. The outstanding difference between the control system in Fig. 2 and that of Fig. 1 is that in Fig. 2 there are two selector switches 2 and 2' which are coupled to cutter 1, and whose arcuate segments are so disposed as to cooperate with the spots on paper 3 so that simultaneous occurrence of closure of selector switch 2 and the photo-tube impulse will denote that the paper speed is too fast, whereas simultaneous occurrence of the closure of selector switch 2' and the photo-tube impulse will denote that the paper speed is too slow.

Selector switch 2 in Fig. 2 is the same as selector switch 2 in Fig. 1, inasmuch as it operates when the paper is travelling too fast and is for the purpose of completing a control circuit for effectively slowing down the paper, such control circuit including essentially tube 15, condenser 21, tube 24, and relay coil 25.

A duplicate control circuit is associated with selector switch 2', which selector switch is for the purpose of completing a control circuit when the paper speed is too slow so as to effect speeding up of the paper. A duplicate control circuit similar to that associated with selector switch 2 is provided for selector 2', including essentially tube 15', condenser 21', tube 24', and relay coil 25'. In other words, corresponding parts of the duplicate control circuits are denoted by the same numerals but with a prime, for example, condenser 21' corresponds to condenser 21, etc. For simplicity, the voltage doubler circuit has not been shown in Fig. 2 but the direct current source of potential has been indicated by the plus and minus symbols. A single photo-tube 5 and a single amplifier tube 11 is used in Fig. 2, thus corresponding exactly to Fig. 1. The speed changer in Fig. 2 has been indicated somewhat differently from that in Fig. 1. The speed changer in Fig. 2 comprises essentially a mechanical differential whose casing 43 is rotatable by a worm gear 38 which is driven by a reversible motor 39 having reversing windings 40 and 41.

The operation of the control system shown in Fig. 2 is as follows: Assume that the paper speed is too slow. This condition will result in the bridging of the contact members of selector switch 2' at the time a photo-tube impulse occurs resulting in a sudden decrease in the current flowing through tube 11 which in turn causes tubes 15' to 24' to become conductive in the manner explained in detail herein in connection with Fig. 1. As tube 24' becomes conductive a circuit will be completed from the source of alternating current supply shown, through relay coil 25 which will effect closing of its associated contact members, thereby completing a circuit from the direct current source of supply shown through reversing coil 41 which effects rotation of worm gear 38 in a particular

direction such as to increase the speed of rollers 31' with reference to the speed of the driving motor 28, thereby increasing the speed of the paper. In a similar manner if the paper speed should be too fast, selector switch 2 will complete a control circuit which effects decrease in the current of tube 11, making tubes 15 and 24 conductive, and thus energizing relay coil 25 and winding 40, thus effecting rotation of the differential gearing casing 43 in an opposite direction, thereby effecting a decrease in the speed of the paper 3.

While my invention has been described in connection with a paper cutting machine, it will be apparent that it is not restricted to such machine but it may be readily applied to any type of wrapping or packaging machine, or in fact, it may be readily applied to any machine wherein it is desired to make the amount of speed restoration in the direction of synchronism proportional to the amount of deviation from synchronism of a pair of rotatable elements. My invention is also suitable in any situation wherein it is desired to have a relay means energized for a period which is proportional to the period of closure of a pair of contact members.

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 drawings 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 machine for cutting a moving strip of material into a plurality of pieces of equal length including, electrically controlled variable speed means for driving said strip material, a rotating cutter for cutting said strip, switching means coupled to said cutter and effective to partially complete a control circuit for said variable speed means, including a grid controlled thermionic tube having connected in the anode circuit thereof in series circuit relationship, said switching means and condenser, photoelectric means actuated by indicia on said strip for completing said control circuit thereby effecting operation of said variable speed means, and circuit means for maintaining said control circuit closed and said variable speed means actuated for a time which is proportional to the abnormality or displacement of said strip of material from synchronism with said cutter.

2. A machine for cutting a moving strip of material into a plurality of pieces of equal length, including, variable speed means for driving said strip of material, a rotating cutter for cutting said strip, switching means coupled to said cutter and effective to partially complete a control circuit for said variable speed means, including a grid controlled thermionic tube having connected in the anode circuit thereof, in series relationship, said switching means and a condenser; a second grid controlled thermionic tube, the discharge of said condenser through said first mentioned thermionic tube being effective to control the duration of break down of said second thermionic tube, a relay in circuit relationship with said second thermionic tube for actuating said variable speed means, the time of closure of said switching means, hence the discharge period of said condenser and the energization period of said relay and variable speed means being directly proportional to the amount of displacement

of said strip from synchronism with respect to said cutter, thereby restoring the speed of said sheet to synchronism with said cutter with substantially no hunting.

3. A photoelectric relay for register control including, in combination, a grid controlled thermionic tube, a parallel circuit across the anode and another terminal of said tube, said parallel circuit including in series relationship, a charging condenser, a resistor and a selector switch, said resistor being effective to control the charging condenser terminal voltage as a function of the time during which the selector switch stays closed, a second grid controlled thermionic tube, the grid of which is in circuit relation to said parallel circuit, an alternating current source of power and a relay connected in series across the anode and cathode of said second thermionic tube, said thermionic tube being effective to break down during a period which corresponds to the period during which said selector switch stays closed.

4. A machine including a pair of rotatable elements, the speeds of which it is desired to maintain at a constant relative value, speed changing means connected to one of said rotatable elements for compensating for departures from synchronism of said pair of rotatable elements, a selector switch, one of the contact members of which is driven by one of said rotatable elements, a control circuit which is partially completed as the result of an abnormal deviation in speed of said rotatable elements from their optimum relative value, said control circuit including a thermionic tube, and said selector switch and a serially connected condenser being connected across the anode and another terminal of said thermionic tube, a source of direct current potential for charging said condenser, said selector switch being effective to complete said partially completed circuit to allow said condenser to discharge through said thermionic tube for a period which is proportional to the period during which said control circuit is completed by said selector switch, a relay circuit which is controlled by said condenser discharge and which is completed for a period which is equal to the period of said condenser discharge and which is effective to operate said speed changing means during such a period, only.

5. A machine including a pair of rotatable elements, the speeds of which it is desired to maintain at a constant relative value, speed changing means connected to one of said rotatable elements for compensating for departures from synchronism of said pair of rotatable elements, a selector switch, one of the contact members of which is driven by one of said rotatable elements, a control circuit which is partially completed as the result of an abnormal deviation in speed of said rotatable elements from their optimum relative value, said control circuit including a thermionic tube, and said selector switch and a serially connected condenser being connected across the anode and another terminal of said thermionic tube, a source of direct current potential for charging said condenser, said selector switch being effective to complete said partially completed circuit to allow said condenser to discharge through said thermionic tube for a period which is proportional to the period during which said control circuit is completed by said selector switch, a relay circuit which is controlled by said condenser discharge and which is completed for a period which is equal to the

period of said condenser discharge and which is effective to operate said speed changing means during such a period, only, a said relay circuit including a second thermionic discharge tube and a relay coil, said speed changing means energizable by said relay coil for effecting said speed change, said relay circuit after once being interrupted as the result of opening of the contact members of said selector switch being ineffective to be completed again until said control circuit is again closed as the result of an abnormal departure of said rotatable elements from said optimum relative speed.

6. A machine for cutting up a moving strip of material into a plurality of pieces of equal length including variable speed means for driving a sheet of material, a rotating cutter for cutting said sheet, a pair of switching means coupled to said cutter, each of which is effective to partially complete one of a pair of control circuits for said variable speed means, each control circuit including a grid controlled thermionic tube having connected across the anode and cathode thereof, in series relationship, one of said switching means and a condenser, photoelectric means actuated by markings on said paper for completing one of said control circuits, depending upon whether the paper is moving too fast or too slow, thereby effecting operation of said variable speed means to restore the speed to a normal value, and circuit means for maintaining each of said control circuits closed and said variable speed means actuated for a time which is proportional to the abnormality or displacement of said strip of material from synchronism with said cutter.

7. A machine for cutting up a moving strip of material into a plurality of pieces of equal length including variable speed means for driving a sheet of material, a rotating cutter for cutting said sheet, a pair or switching means coupled to said cutter, each of which is effective to partially complete one of a pair of control circuits for said variable speed means, each control circuit including a grid controlled thermionic tube having connected across the anode and cathode thereof, in series relationship, one of said switching means and a condenser; a second grid controlled thermionic tube, the discharge of said condenser through said first mentioned thermionic tube being effective to control the duration of break down of said second thermionic tube, a relay in circuit relationship with said second thermionic tube for actuating said variable speed means, the time of closure of each of said switching means, hence the discharge period of the corresponding condenser and the energization period of each relay and variable speed means being directly proportional to the amount of displacement of said sheet from synchronism with respect to said cutter, thereby restoring the speed of said sheet to synchronism with said cutter with a minimum amount of hunting.

8. A machine including a pair of rotatable elements, the speeds of which it is desired to maintain at a constant relative value, speed changing means connected to one of said rotatable elements for compensating for departures from synchronism of said pair of rotatable elements, a pair of selector switches, one of the contact members of each pair of which is driven by one of said rotatable elements, a pair of control circuits each of which is partially completed as the result of an abnormal deviation in speed of said rotatable elements from their op-

imum relative value depending upon whether the speed is too fast or too slow, said control circuits including a thermionic tube, and one of said selector switches and a serially connected condenser being connected across the anode and cathode of said thermionic tube, a source of direct current potential for charging said condenser, said last mentioned selector switch being effective to complete said partially completed circuit to allow said condenser to discharge through said thermionic tube for a period which is proportional to the period during which the control circuit is completed by the selector switch, a relay circuit which is controlled by said condenser discharge and which is completed for a period which is equal to the period of said condenser discharge and which is effective to operate said speed changing means during such a period, only, there being one relay for each control circuit, one for effecting increase in speed and the other for effecting decrease in speed of the paper.

9. A machine including a pair of rotatable elements, the speeds of which it is desired to maintain at a constant relative value, speed changing means connected to one of said rotatable elements for compensating for departures from synchronism of said pair of rotatable elements, a pair of selector switches, one of the contact members of each pair of which is driven by one of said rotatable elements, a pair of control circuits each of which is partially completed as the result of an abnormal deviation in speed of said rotatable elements from their optimum relative

value depending upon whether the speed is too fast or too slow, said control circuits including a thermionic tube, and one of said selector switches and a serially connected condenser being connected across the anode and cathode of said thermionic tube, a source of direct current potential for charging said condenser, said last mentioned selector switch being effective to complete said partially completed circuit to allow said condenser to discharge through said thermionic tube for a period which is proportional to the period during which the control circuit is completed by the selector switch, a relay circuit which is controlled by said condenser discharge and which is completed for a period which is equal to the period of said condenser discharge and which is effective to operate said speed changing means during such a period, only, there being one relay for each control circuit, one for effecting increase in speed and the other for effecting decrease in speed of the paper, each of said relay circuits including a second thermionic discharge tube together with the relay coil, said speed changing means energizable by said relay coil for effecting said speed change, said relay circuit after once being interrupted as the result of opening of the contact members of said selector switch being ineffective to be completed again until said control circuit is again closed as the result of an abnormal departure of said rotatable elements from said optimum relative speed.

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