Nov. 12, 1957 L. H. HASKIN, JR., ET AL 2,812,938

REGISTERING DRIVE FOR A WEB

Filed March 11, 1954

2 Sheets-Sheet 1

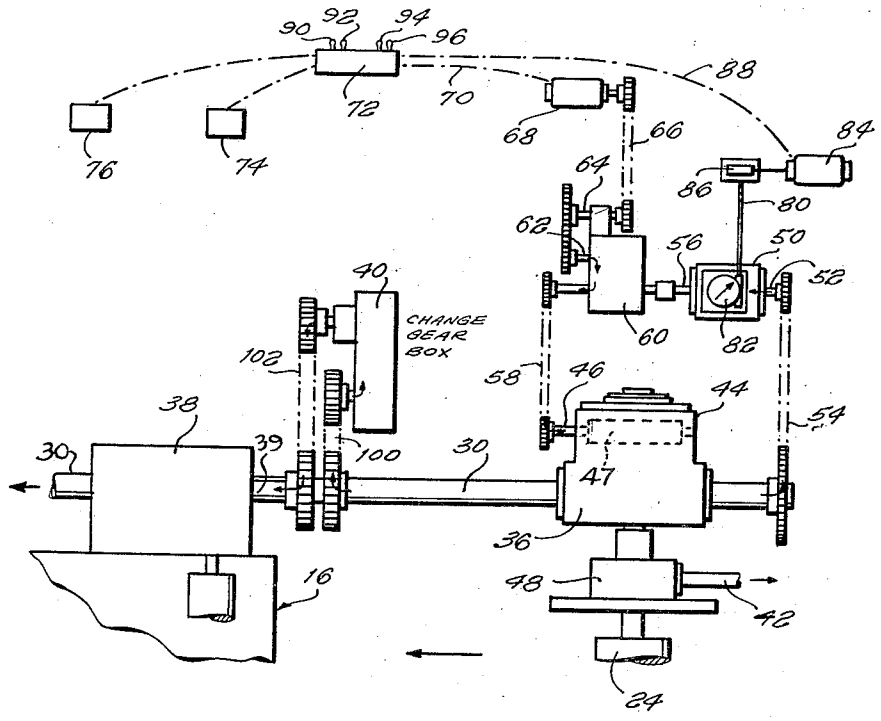
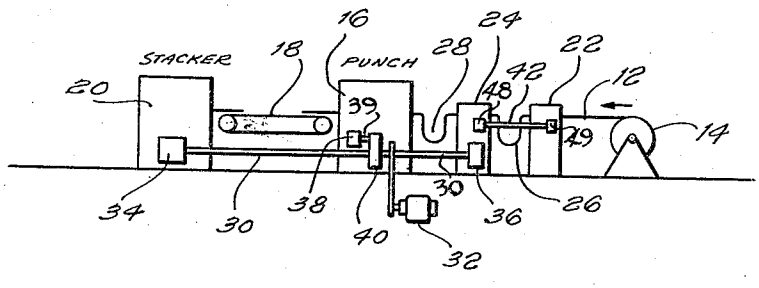


FIG. 1.

FIG. 2.



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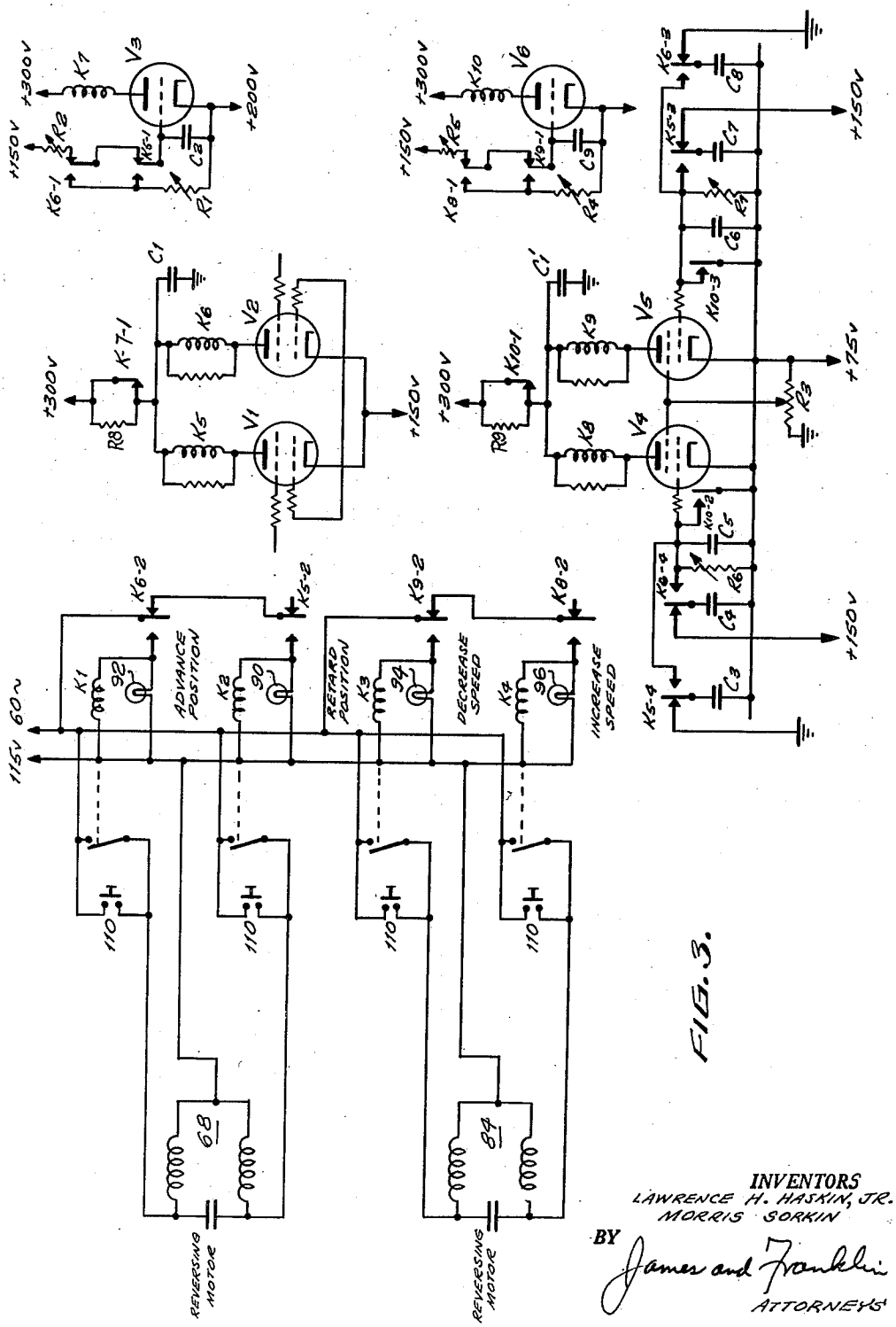


FIG. 3.

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REGISTERING DRIVE FOR A WEB

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Application March 11, 1954, Serial No. 415,672

22 Claims. (Cl. 271—2.6)

This invention relates to registering drives for a web, and more particularly to an automatically registering drive for a printed web.

There are many situations in which a single web is run through a series of machines which must be driven at different rotative speeds. One might be a printing press (or a line of printing presses) leading to a punch press which severs the web into sheets. For purposes of the present description a metering feed unit which feeds the web at a carefully measured rate may be considered a machine, because exactly the same problem arises when pulling a previously printed web from a roll and feeding it through a punch press. The rotational speed ratio between the feed unit and the punch press may vary widely, because of changes in the size of the printed sheet, it being understood that the feed unit would turn less when the sheets being cut by the punch press are short, and would turn more when the sheets are long.

Infinitely variable drives are known, and may be either frictional or positive, but even the so-called positive drive tends to drift somewhat, and is not as satisfactory in this respect as simple spur teeth gearing. On the other hand, a change gear box, even if somewhat elaborate, may not establish exactly the desired sheet length, because a minimum change of a single tooth in a single gear, even if making a difference in sheet length which may be reduced to only thousandths of an inch, may nevertheless prove troublesome because the error is cumulative.

One object of the present invention is to retain the benefit and yet minimize the disadvantages of the infinitely variable drive, and with this object in view we provide a main or primary change gear box which makes it possible to obtain a speed ratio which is exactly or very close to that desired. We further employ a running register of the differential gear type between the change gear box and one of the machines, and we employ an infinitely variable drive to feed a slight corrective component to the correction feed-in shaft of the running register. Thus any drift of the infinitely variable drive is applicable to only a minute component of the total motion applied.

Difficulty may arise because of a change in the density and consistency of the web, particularly when working with cardboard. It is rare that the final print lengths correspond exactly to the theoretical length, for there is contraction or expansion of the web resulting from the effect of the driers which follow the printing units, and from the tension exerted in the printing units during the printing operation. Moreover, the feed of such a web is usually obtained by wrapping the web around a cylinder, and thus half the thickness of the web is added to the radius of the cylinder in arriving at the so-called "neutral axis" of the web. However, because of changes in character of the web material, the neutral axis does not invariably remain in the physical center of the web. Also there may be differences in thickness. All these differences cause a so-called "repeat variation," meaning that the deviation in length repeats itself substantially constantly for a time, although it may vary in the course of a single roll, and usually varies from one roll to another.

This would cause great difficulty with a change gear box alone, even if so constructed as to make possible changes in blank length of only a few thousandths of an inch, for the gear ratio could not be changed while the machine is running, nor in a gradual correction-seeking manner. The difficulty is largely overcome by use of the infinitely variable drive, for its ratio may be changed while the machine is running. The amount of change needed for this purpose may be kept quite small, a range of change of, say, 1/16" being ample for sheets about 3 ft. long. This helps show how small a component of the motion is being supplied by the infinitely variable drive, and in practice we prefer to use a drive which is reversible, and to establish a gear ratio in the change gear box which is substantially correct. However, it is also possible to employ an infinitely variable drive which is not reversible, and to establish a speed ratio in the change gear box which is very slightly offset from the theoretically correct ratio. The difference is made up by a middle adjustment of the infinitely variable drive, thus permitting use of a drive which is not reversible.

In accordance with a further feature and object of the present invention, provision is made for correcting any slight residual or occasional error by "position" correction, and for this purpose another running register of the differential gear type, which we shall call a position correcting register, is inserted between the infinitely variable drive and the correction feed-in shaft of the main running register. The position correcting register has a feed-in shaft driven by a reversing motor which is operated briefly at intervals, preferably in response to an automatic detector system of known type, usually a photoelectric eye system cooperating with a marker on the web.

Still another object is to facilitate normal correction of the adjustment of the infinitely variable drive when needed, and for this purpose the increments of electric power used to drive the position correcting motor are also supplied to red and green lamps or equivalent signals, so that a series of repeated flashes of one color will indicate the need for readjustment of the infinitely variable drive.

A still further object of the invention is to provide automatic control means for readjusting the said drive. A more specific object is to provide such a means which will change the adjustment only after a cumulative series of position adjustments which are all in one direction. Another specific object is to cause a position adjustment in one direction to cancel out a position adjustment in the opposite direction, thereby eliminating random errors, and distinguishing between such errors and an error in speed ratio. Still another specific object is to initiate a corrective change in speed ratio only if the cumulative series of like changes takes place in a predetermined short interval of time, for the machinery here controlled, although sensitive, is ponderous, and it does not pay to attempt a change in ratio when the error is so slight that it takes a considerable period of time to accumulate enough error to be noticed by the photoelectric eye or like detector system, and such an error is best treated as a position error to be corrected as such, rather than as an error in gear ratio.

To accomplish the foregoing objects, and such other objects as will hereinafter appear, our invention resides in the registering drive elements, and their relation one to another, as are hereinafter more particularly described

in the following specification. The specification is accompanied by drawings, in which:

Fig. 1 is a schematic diagram of a drive embodying features of our invention;

Fig. 2 shows a group of units with which our improved drive may be employed; and

Fig. 3 is a schematic wiring diagram applicable to the drive.

Referring to the drawing, and more particularly to Fig. 2, a previously printed web **12** is drawn from a roll **14** and is to be fed through a punch press **16**, where it is cut into sheets which are transferred by suitable means **18** to a stacker **20**. The web is pulled from the roll **14** and is fed to the punch **16** by means of a first metering or feed unit **22**, and a second metering or feed unit **24**, with a slack loop **26** therebetween. There is also a slack loop **28** between feed unit **24** and punch press **16**, but it will be understood that this is variable and merely to accommodate the intermittent action of the punch press, while the web dwells in the press, and accordingly the loop **28** disappears for an instant during each cycle of the press. In the present case the feed unit **24** is provided with means for automatic side-to-side register, and it is primarily because of this that the first feed unit **22** is used, for its main purpose is to provide the slack loop **26**, which in turn facilitates operation of the side-to-side register in feed unit **24**. Without the side-to-side register a single feed unit preceding the punch press would be adequate.

There is a main drive shaft **30** driven by a motor **32**, and shaft **30** drives the stacker **20** through gearing housed at **34**. It drives the feed unit **24** through gearing housed at **36**. It drives the punch press **16** through gearing housed at **38** and through a shaft **39** and a main change gear box **40** which establishes almost the exact desired speed ratio between the feed unit **24** and the punch press. The change gear box **40** could be interposed between the main shaft and the feed unit **24**, instead of between the main shaft and the punch press **16**. Either of the gear housings **36** and **38**, in this case gear housing **36**, carries a running register of the differential gear type. The two feed units **22** and **24** are driven in unison, as by means of a special connecting shaft **42**, connected through gearing at **48** and **49**, and are connected through the feed unit **24**, and gearing at **36**, to the main drive shaft **30**.

Referring now to Fig. 1 of the drawing, the main shaft **30** is connected to the punch press **16** through change gear box **40** and additional gear housing **38**, as is clearly shown. The drives **100** and **102** may be chain or gear drives. The main shaft **30** is connected to the metering or feed unit **24** through a gear housing **36** which includes a running register **44** the correction feed-in shaft and worm of which are shown at **46** and **47**. The running register of differential gear type need not be explained in detail, it being shown in the U. S. Patent No. 2,163,035 issued June 20, 1939, to the assignee of William F. Grupe. The shaft which inter-connects the first and second feed units, and drives the same in unison, is shown at **42**, and operates through bevel gearing or equivalent at **48**.

The infinitely variable drive is shown at **50**. Its input shaft **52** is driven at constant speed by main shaft **30** through a chain drive **54**. The output shaft **56** is connected through a chain drive **58** to the feed-in shaft **46** of the running register **44**. The variable speed drive shown is a Graham drive, which is reversible. Non-reversible variable speed drives such as the Reeves, and the P. I. V. drive made by Link Belt, as well as other standard reversible or non-reversible drives may be used.

Another running register of the differential gear type is shown at **60**, this being interposed between the infinitely variable drive **50** and the feed-in shaft **46** of running register **44**. The differential gear mechanism **60** is a position correcting register, for it is run only intermittently for short intervals of time. Its feed-in shaft **62** is driven through an intermediate shaft **64** and chain drive **66** by a reversing motor **68**. The reversing motor may be either an alternating current or direct current motor, and in the present case is an alternating current motor with built-in reduction gearing. The motor is itself controlled through wiring indicated schematically by line **70** connected to a panel box **72**, which in turn forms a part of an electric eye registration control system of the type disclosed more fully in Patent No. 2,348,862 entitled, "Registration Control Apparatus," and issued May 16, 1944, to the assignee of Morris Sorkin, one of the present inventors. The detector system includes a photoelectric eye **74** and a phase detector **76**.

The gear ratio of the variable drive **50** is adjusted by rotation of a control shaft **80**. Such drives commonly have an indicator, shown at **82**, but the indicator is not important or significant for the present purpose because the adjustment is preferably accomplished automatically. For this purpose we provide another reversible motor **84**, which is preferably like the motor **68**. In the present case it is a reversing A. C. motor with built-in gear reduction. The motor **84** drives adjusting shaft **80** through a gear reduction, for example using a worm **86**. The motor is connected to the panel box **72** through appropriate connections, here indicated by a single line **88**.

At the panel box **72**, or at any other convenient and desirable location, we provide a pair of signals **90** and **92**. Most simply and in the present case these are a red and green lamp respectively. These indicate the operation of the position correcting motor **68**. If desired another pair of red and green signal lamps **94** and **96** may be provided to indicate the operation of the speed ratio adjusting motor **84**.

Fig. 3 is a wiring diagram for the apparatus, but the diagram has been simplified by showing only a fragmentary part of the diagram of the photocell or electric eye registration circuit, which is disclosed fully in the aforesaid Sorkin Patent 2,348,862. The diagram of Fig. 3 is readily related to and may be combined with the diagram in the Sorkin patent with the following information. The tubes V1 and V2 are thyratron tubes which correspond to tubes **65** and **66** in the patent. The tube V3 corresponds to the tube **85** in the patent. The relays K5 and K6 correspond to relays **75** and **78** in the patent, and the relay K7 corresponds to relay **84** in the patent.

There are a number of relays used, some of which have a considerable number of contacts moved in unison, but in order to simplify the diagram in accordance with up-to-date "across the line" practice, the contacts have been located where their switching function is performed, and are not grouped together as they are structurally. However, the relay coils are numbered, and the relay contacts are similarly numbered but with an additional numeral to indicate which of the multiple contacts of the relay is referred to. In Fig. 3 all of the relays are shown de-energized, and in the description the term "make" is used to refer to the condition of the relay when it is energized.

The upper part of the wiring diagram, including the main relays K5 and K6 controlled by thyratron tubes V1 and V2, are a part of the position correcting registration system as described in the aforesaid Sorkin Patent 2,348,862. They control the position correcting motor **68**. The lamps **92** and **90** are shunted across the two sides of the reversible motor control circuit and may be colored green and red, green indicating that the web is being advanced and red indicating that the web is being retarded. The tube V3 acts as a timer, it having a condenser C2 and a resistor R1, the adjustment of which determines how long an interval will take place before the thyratron tube is made non-conductive after being made conductive. Thus the position correcting

motor may run for a brief interval of time, say a fraction of a second, which may be one-third to one-tenth as long as the time it is off before it can again be run, as explained in Patent 2,348,862.

The lower part of the circuit is a symmetrical circuit centering about thyratron tubes V4 and V5 controlling relays K8 and K9, much as in the upper part of the circuit, except that in the lower circuit there is a pulse accumulating action. More specifically, there is a small condenser C7 (or C4) which for each pulse discharges into a large condenser C6 (or C5), thereby raising the potential across the large condenser a predetermined amount, say one volt. After a desired number of pulses, the potential across the large condenser C6 is high enough to make the thyratron V5 conductive, thereby operating the relay K9. The number of pulses required to operate the relay, say five to ten pulses, will depend on the bias of the thyratron tube, which in turn is controlled by the potentiometer R3.

The group of successive pulses must take place within a limited time, say fifteen to thirty seconds, in order to operate the relay. For this purpose there is a resistor R7 connected across the large condenser C6 and acting as a leak, and the adjustment of the resistor R7 determines the time period within which the desired number of pulses must take place.

The successive pulses must be in the same direction. If of opposite direction they cancel out. The reason for this is explained later.

After each operation of either relay the circuit is recycled, and for this purpose the condensers C5 and C6 are discharged completely, for which purpose there are extra contacts on the relay K10 which shunt the condensers C5 and C6. Relay K10 is controlled by tube V6 which is a timer tube which controls for how long an interval the speed correcting motor 84 will run. This in turn is adjusted by the resistor R4. The interval may be a matter of a fraction of a second, say, ⅛ to ½ a second, and the motor is then kept off for a longer time, say, three to ten times as long.

The operation may be described in greater detail as follows. The thyratrons V1 and V2 receive pulses from a "web amplifier" as picked up by the photoelectric web scanner, and by the early and late gates from the phase detector. If the web pulse coincides in time with any portion of the "early gate" thyratron V1 conducts and energizes relay K5. If the web pulse coincides in time with any portion of the "late gate," thyratron V2 conducts and energizes relay K6. Relays K5 and K6 each have four sets of contacts. Set #1, that is, contacts K5–1 or K6–1, start the interval timer V3. Set #2, that is, contacts K5–2 or K6–2, control indicator lights 90 and 92 and the position control motor 68, through appropriate contactors K1 and K2 if electric motors are used as here shown; or electrically controlled valves if hydraulic or pneumatic motors are used. These two sets of contacts are all that the relays have in Patent 2,348,862, but in order to expand their function to include automatic speed correction, two extra sets of contacts are added to each. Sets #3 and #4 feed information to the new circuit shown in the lower part of Fig. 3.

In order to illustrate the operation of the new circuit let us assume that the web is ahead of the position which it should have for proper registration. The following sequence of events takes place:

(1) Web pulse coincides with "early gate."

(2) Thyratron V1 conducts.

(3) Relay K5 is energized, switching the movable contacts to the "make" position.

(4) Contacts K5–1 start the interval timer consisting of tube V3 and associated components.

(5) Contacts K5–2 energize "retard position" indicator light 90 and motor contactor K2.

(6) Contacts K5–3 disconnect capacitor C7 from +150 volts supply and connect it across storage capacitor C6. Since C7 was charged by the voltage difference of +75 volts (150 v. −75 v.) and the ratio of capacitors C7/C6 is, say, 80, the voltage across storage capacitor C6 rises by .92 volt.

(7) Contacts K5–4 disconnect capacitor C3 from 0 volt and connect if across capacitor C5. Since C3 was charged by the voltage difference of −75 volts (0–75 v.) and the ratio of capacitors C3/C5 is 80, the voltage across C5 is decreased by .92 volt.

(8) Tube V3 conducts after an interval determined by capacitor C2 and resistor R1, thereby energizing a relay K7, and opening contact set K7–1.

(9) Contacts K7–1 open, cutting off the plate current of the thyratron V1, and so releasing relay K5 and switching the movable contacts to the "break" position.

(10) Contacts K5–1 switch capacitor C2 to +150 volts, through contacts K6–1 and R2. Contacts K5–2 cut off "retard position" indicator light 90 and motor contactor K2. Contacts K5–3 reconnect capacitor C7 to +150 volts. Contacts K5–4 reconnect capacitor C3 to 0 volt.

(11) Tube V3 is cut off after an interval determined by capacitor C2 and resistor R2, releasing relay K7, and reconnecting the plate of thyratron V1 to +300 volts, through relay K5.

(12) The quiescent condition is now restored, with all relay contacts in the position shown in the diagram. The voltage across capacitor C6 has increased by .92 volt.

If we assume that the web next lags behind its proper position, the following sequence of events takes place.

(13) Web pulse coincides with "late gate."

(14) Thyratron V2 conducts.

(15) Relay K6 is energized, switching the movable contacts to the "make" position.

(16) Contacts K6–1 start the interval timer centering about tube V3.

(17) Contacts K6–2 energize "advance position" indicator light 92 and motor contactor K1.

(18) Contacts K6–3 disconnect capacitor C8 from 0 volt and connect it across storage capacitor C6, thereby decreasing the voltage across C6 by .92 volt.

(19) Contacts K6–4 disconnect capacitor C4 from +150 volts supply, and connect it across storage capacitor C5, thereby increasing the voltage across C5 by .92 volt.

(20) The interval timer relay K7 operates after the predetermined time to cut off plate current of thyratron V2, releasing relay K6, and restoring the quiescent conditions as outlined in steps 8 through 12 above.

The voltage across storage capacitor C6 has decreased by .92 volt, making the control grid of thyratron V5 more negative by .92 volt. The voltage across storage capacitor C5 has increased by .92 volt, making the control grid of thyratron V4 more positive by .92 volt.

We see that the result of conduction of thyratron V2 upon storage capacitors C5 and C6 is the negative of the effect of conduction of thyratron V1. Therefore, as long as thyratrons V1 and V2 conduct alternately, or in a random sequence, such as would occur if the speed of the web feeding device is correct, the voltage across storage capacitor C5 or C6 does not increase sufficiently to cause either thyratron V4 or V5 to conduct.

If, however, the speed of the feeding device is incorrect, the voltage across either storage capacitor C5 or C6 will increase cumulatively and sufficiently to cause either thyratron V4 or V5 to conduct.

Let us assume that the speed is low. Then thyratron V2 will conduct on successive web pulses, relay K6 will operate successively; and the voltage across storage capacitor C5 will build up, increasing the control grid voltage of thyratron V4 until is conducts, thereby energizing relay K8.

Relay K8 operates, switching the movable contacts

to the "make" position. Contacts K8–1 start an interval timer, consisting of tube V6 and associated circuit.

Contacts K8–2 energize the "increase" speed correction motor contactor K4, and "increase speed" green light indicator 96.

After the time interval, determined by C9 and R4, relay K10 is energized by tube V6 and operates, opening contacts K10–1 and cutting off thyratron V4. Contacts K10–2 discharge storage capacitor C5 and contacts K10–3 discharge storage capacitor C6. After a time interval determined by C9 and R5, tube V6 is cut off, relay K10 is de-energized, and the movable contacts return to the "break" position, restoring the circuit to the initial condition.

If the speed is high, thyratron V5 will conduct, after the voltage across storage capacitor C6 builds up, and will energize relay K9. This operates the timer circuit of tube V6; the "decrease speed" motor contactor K3 and red indicator light 94. After an interval the relay K10 cuts off thyratron V5, discharges storage condenser C6, and reconnects thyratron V5 to restore the initial conditions.

In this discussion so far the variable resistors R6 and R7 across the storage capacitors C5 and C6, respectively, have been ignored. As described so far, the voltage across C5 and C6 is proportional to the sum of the number of operations of thyratron V2 minus the sum of the number of operations of thyratron V1. However, since the rate rather than the number of operations of V2 and V1 is proportional to the speed error, a leak resistor R6 is connected across storage capacitor C5, and a leak resistor R7 across storage capacitor C6, to establish a time constant. If the time between successive operations of thyratron V2 (or V1) is long compared to the time constant, the voltage across storage capacitors C5 and C6 will not build up, even if all corrections are in the same direction. If the time between operations is comparable to the time constant, the voltage across storage capacitors C5 and C6 will build up at a time dependent on the speed error. Leak resistors R6 and R7 are variable to allow for setting the optimum time constant.

It will be noted that the motor circuits may be closed by pushbutton switches shown at 110. This is for convenience in working on or adjusting the apparatus. Such switches may be provided at the panel box, or other desired control point.

In a specific example of the invention the punch press 16 (Fig. 2) handles sheets in range of from 17" to 34" long. The change gear box 40 is a compound four-gear change gear box of known character. This employs three shafts, two of which are stationary while the intermediate shaft is floating or movable, thus making possible many gear combinations. Changes are also possible though not ordinarily required in the chain drives 100 and 102. The main shaft 30 is driven at about 450 R. P. M. The input shaft 52 of the variable speed drive is driven at about 1700 R. P. M. The drive is a "Graham" reversible drive with an output speed at shaft 56 of plus or minus 300 R. P. M. maximum. The motors 68 and 84 are "Jannett" reduction gear motors having an output speed of about 36 R. P. M.

Referring now to Fig. 3, the tubes V1, V2, V4 and V5 are #2051 thyratron tubes or equivalent. The tubes V3 and V6 are medium Mu triodes such as type 76 or equivalent. The relays K, K2, K3 and K4 are contactors suitable for the correction motors. The relays K5 and K6 are D. C. relays having a coil resistance of 11,000 ohms and having four single pole double throw contacts. The relay K7 is a D. C. relay having a coil resistance of 11,000 ohms and having one normally closed contact. The relays K8 and K9 are D. C. relays having a coil resistance of 11,000 ohms and having two single pole double throw contacts. The relay K10 is a D. C. relay having a coil resistance of 11,000 ohms and having one normally closed contact and two normally open contacts.

The resistor R1 determines the "on" time for position correction and has a value of 500,000 ohms. The resistor R2 determines the "off" time for position correction, and has a value of 500,000 ohms. Resistance R3 determines the number of cumulative corrections in the same direction which must take place in order to operate the speed correction motor 84, and has a value of 100,000 ohms. Resistance R4 determines the "on" time of the speed correcting motor 84 and has a value of 500,000 ohms. Resistance R5 determines the "off" time of the speed correcting motor 84 and has a value of 500,000 ohms. Resistances R6 and R7 determine the time constant of the speed correction, that is, the minimum time during which the predetermined number of cumulative corrections must take place in order to operate the speed correcting motor, and have a value of 5 megohms. Resistors R8 and R9 are 10 megohms.

In the specific circuit shown condensers C1 and C_1' have a value of 0.01 mfd.; condensers C2 a value of 0.25 mfd.; condensers C3, C4, C7 and C8 a value of 0.05 mfd.; and condensers C5 and C6 a value of 4 mfd. The resistors shunted around the contacts #1 of relays K7 and K10 have a value of 10 megohms. Typical voltages are indicated directly on the drawing. Variable resistor values are given at maximum.

It will be understood that all of the foregoing quantitative values are given solely by way of illustration of one example of the invention, and are not intended to be in limitation of the invention.

It is believed that the construction and operation of our improved registering drive for a web, as well as the advantages thereof, will be apparent from the foregoing detailed description thereof. It will also be apparent that while we have shown and described our invention in a preferred form, many changes may be made without departing from the scope of the invention, as sought to be defined in the following claims.

We claim:

1. Apparatus including a first machine and a second machine for a single web, and mechanical drive means between said first machine and said second machine, said drive means including a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said shaft and one of said machines, an infinitely variable drive, the input of said drive being connected to and driven by said main shaft and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correcting register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correcting register, and means to operate the said motor briefly at intervals.

2. Apparatus including a first machine and a second machine to be driven at different rotative speeds for working on a single web fed from said first machine to said second machine, and mechanical drive means between said first machine and said second machine, said drive means including a wide range change gear box for readily establishing a positive ratio which is close to the desired speed ratio between the machines, a running register of the differential gear type between said change gear box and one of said machines, an infinitely variable drive, the input of said drive being connected to and driven by said change gear box and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first ma-

chine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correction register, and circuit means to control said motor.

3. Apparatus including a punch press and a metering feed unit for feeding a single web to the punch press, and mechanical drive means between said feed unit and said punch press, said drive means including a wide range change gear box for readily establishing a positive ratio which is either exactly or very close to the desired speed ratio between the feed unit and punch press, a running register of the differential gear type between said change gear box and one of the machines, an infinitely variable and reversible drive, the input of said drive being connected to said change gear box and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the feed unit and the punch press, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correction register, and circuit means to control said motor.

4. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correcting register, and means to operate the said motor briefly at intervals, said means including a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to restore registration.

5. Apparatus including a first machine and a second machine to be driven at different rotative speeds to operate on a single web having register markers, a wide range change gear box for readily establishing a positive ratio which is very close to the desired speed ratio between the machines, one end of said change gear box being connected to one of said machines a running register of the differential gear type between the other end of said change gear box and the other of said machines, an infinitely variable drive, the input of said drive being connected to and in drive with said change gear box and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correction register, and means to operate the said motor briefly at intervals, said means including a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to restore registration.

6. Apparatus including a first machine and a second machine to be driven at different rotative speeds to operate on a single web having register markers, a wide range change gear box for readily establishing a positive ratio which is either exactly or very close to the desired speed ratio between the machines, one end of said change gear box being connected to one of said machines a running register of the differential gear type between the other end of said change gear box and the other of said machines, an infinitely variable and reversible drive, the input of said drive being connected to and in drive with said change gear box and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system a reversible electric motor connected to the correction feed-in shaft of the position correction register, and means to operate the said motor briefly at intervals, said means including a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to restore registration, said increments also being supplied to differently colored lamps or equivalent signals for the information of an operator who may change the adjustment of the infinitely variable drive.

7. Apparatus including a punch press, a metering feed unit for feeding a printed web having a register marker to said punch press a wide range change gear box for readily establishing a positive ratio which is close to the desired speed ratio between the feed unit and the punch press, one end of said change gear box being connected to one of said machines a running register of the differential gear type between the other end of said change gear box and the other of said machines, an infinitely variable drive, the input of said drive being connected to said change gear box and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the feed unit and the punch press, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system a reversible electric motor connected to the correction feed-in shaft of the position register, and means to operate the said motor briefly at intervals, said means including an electric eye and phase detector system cooperating with the register markers on the printed web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to restore registration.

8. Apparatus including a punch press, a metering feed unit for feeding a printed web having a register marker to said punch press a wide range change gear box for

readily establishing a positive ratio which is either exactly or close to the desired speed ratio between the feed unit and the punch press, one end of said change gear box being connected to one of said machines a running register of the differential gear type between the other end of said change gear box and the other of said machines, an infinitely variable and reversible drive, the input of said drive being connected to said change gear box and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the feed unit and the punch press, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position register, and means to operate the said motor briefly at intervals, said means including an electric eye and phase detector system cooperating with the register markers on the printed web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to restore registration, said increments also being supplied to differently colored lamps or equivalent signals for the information of an operator who may change the adjustment of the infinitely variable drive.

9. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive of the positive type, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power, a reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of corrective increments in one direction to operate said ratio adjusting motor in appropriate direction.

10. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive of the positive type, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power, a reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of corrective increments in one direction to operate said ratio adjusting motor in appropriate direction, and means whereby corrective increments in one direction cancel corrective increments in opposite direction.

11. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive of the positive type, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power, a reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of corrective increments in one direction to operate said ratio adjusting motor in appropriate direction, and means whereby a series of increments is made ineffective to operate the ratio adjusting motor if said series does not take place within a predetermined time.

12. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive of the positive type, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power, a reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of corrective increments in one direction to operate said ratio adjusting motor in appropriate direction, means whereby corrective increments in one direction cancel corrective increments in opposite direction, and means whereby a series of increments is made ineffective to operate the ratio adjusting motor if said series does not take place within a predetermined time.

13. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power, a reversible electric motor arranged to adjust the speed

ratio of the infinitely variable drive, means responsive to a cumulative series of corrective increments in one direction to operate said ratio adjusting motor in appropriate direction, and means whereby a series of increments is made ineffective to operate the ratio adjusting motor if said series does not take place within a predetermined time, said last means comprising a large storage capacitor, a small charging capacitor for charging into the storage capacitor, a tube made conductive when the charge on the storage capacitor reaches a predetermined value, and a resistor shunting the storage capacitor to establish a time constant.

14. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correcting register, and means to operate the said motor briefly at intervals, said means including a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to correct position, a second reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of position corrections in one direction to operate said ratio adjusting motor in appropriate direction.

15. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correcting register, and means to operate the said motor briefly at intervals, said means including a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to correct position, a second reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of position corrections in one direction to operate said ratio adjusting motor in appropriate direction, and means whereby position corrections in one direction cancel position corrections in opposite direction.

16. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correcting register, and means to operate the said motor briefly at intervals, said means including a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to correct position, a second reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of position corrections in one direction to operate said ratio adjusting motor in appropriate direction, and means whereby a series of position corrections even if in the same direction is made ineffective to operate the ratio adjusting motor if said series does not take place within a predetermined time.

17. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correcting register, and means to operate the said motor briefly at intervals, said means including a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to correct position, a second reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of position corrections in one direction to operate said ratio adjusting motor in appropriate direction, means whereby position corrections in one direction cancel position corrections in opposite direction, and means whereby a series of position corrections even if in the same direction is made ineffective to operate the ratio adjusting motor if said series does not take place within a predetermined time.

18. Apparatus including a first machine and a second machine to operate on a web having register markers, a main drive shaft for establishing a positive speed ratio between the machines, a running register of the differential gear type between said main shaft and one of said machines, an infinitely variable drive, the input of said drive being connected to and driven by said main shaft, and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired

speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correcting register, and means to operate the said motor briefly at intervals, said means including a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to correct position, a second reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of position corrections in one direction to operate said ratio adjusting motor in appropriate direction, and means whereby a series of position corrections is made ineffective to operate the ratio adjusting motor if said series does not take place within a predetermined time, said last means comprising a large storage capacitor, a small charging capacitor for charging increments of current into the storage capacitor, a tube made conductive when the charge on the storage capacitor reaches a predetermined value, and a resistor shunting the storage capacitor to establish a time constant.

19. Apparatus including a first machine and a second machine to be driven at different rotative speeds to operate on a single web having register markers, a wide range change gear box for readily establishing a positive ratio which is very close to the desired speed ratio between the machines, one end of said change gear box being connected to one of said machines a running register of the differential gear type between the other end of said change gear box and the other of said machines, an infinitely variable drive, the input of said drive being connected to and in drive with said change gear box and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power, a reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of corrective increments in one direction to operate said ratio adjusting motor in appropriate direction.

20. Apparatus including a first machine and a second machine to be driven at different rotative speeds to operate on a single web having register markers, a wide range change gear box for readily establishing a positive ratio which is very close to the desired speed ratio between the machines, one end of said change gear box being connected to one of said machines a running register of the differential gear type between the other end of said change gear box and the other of said machines, and infinitely variable drive, the input of said drive being connected to and in drive with said change gear box and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power, a reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of corrective increments in one direction to operate said ratio adjusting motor in appropriate direction, means whereby position corrections in one direction cancel position corrections in opposite direction, and means whereby a series of position corrections even if in the same direction is made ineffective to operate the ratio adjusting motor if said series does not take place within a predetermined time.

21. Apparatus including a first machine and a second machine to be driven at different rotative speeds to operate on a single web having register markers, a wide range change gear box for readily establishing a positive ratio which is very close to the desired speed ratio between the machines, one end of said change gear box being connected to one of said machines, a running register of the differential gear type between the other end of said change gear box and the other of said machines, an infinitely variable drive, the input of said drive being connected to and in drive with said change gear box and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correction register, means to operate the said motor briefly at intervals, said means including a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to correct position, a second reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive, means responsive to a cumulative series of position corrections in one direction to operate said ratio adjusting motor in appropriate direction.

22. Apparatus including a first machine and a second machine to be driven at different rotative speeds to operate on a single web having register markers, a wide range gear box for readily establishing a positive ratio which is very close to the desired speed ratio between the machines, one end of said change gear box being connected to one of said machines, a running register of the differential gear type between the other end of said change gear box and the other of said machines, an infinitely variable drive, the input of said drive being connected to and in drive with said change gear box and the output of said drive being connected to the correction feed-in shaft of the running register to form a continuous correction drive system, said infinitely variable drive being adjusted to obtain the exact desired speed ratio between the first machine and the second machine, the arrangement being such that any drift of the infinitely variable drive is applicable to solely the small corrective component introduced by the running register, a position correction register of the differential gear type disposed in the correction drive system, a reversible electric motor connected to the correction feed-in shaft of the position correcting register, means to operate the said motor briefly at intervals, said means including a detector system cooperating with the register markers on the web for detecting deviation from true register and for supplying corrective increments of electric power to drive the electric motor in that direction which tends to correct position, a second reversible electric motor arranged to adjust the speed ratio of the infinitely variable drive,

means responsive to a cumulative series of position corrections in one direction to operate said ratio adjusting motor in appropriate direction, means whereby position corrections in one direction cancel position corrections in opposite direction, and means whereby a series of position corrections even if in the same direction is made ineffective to operate the ratio adjusting motor if said series does not take place within a predetermined time.

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