

April 24, 1962

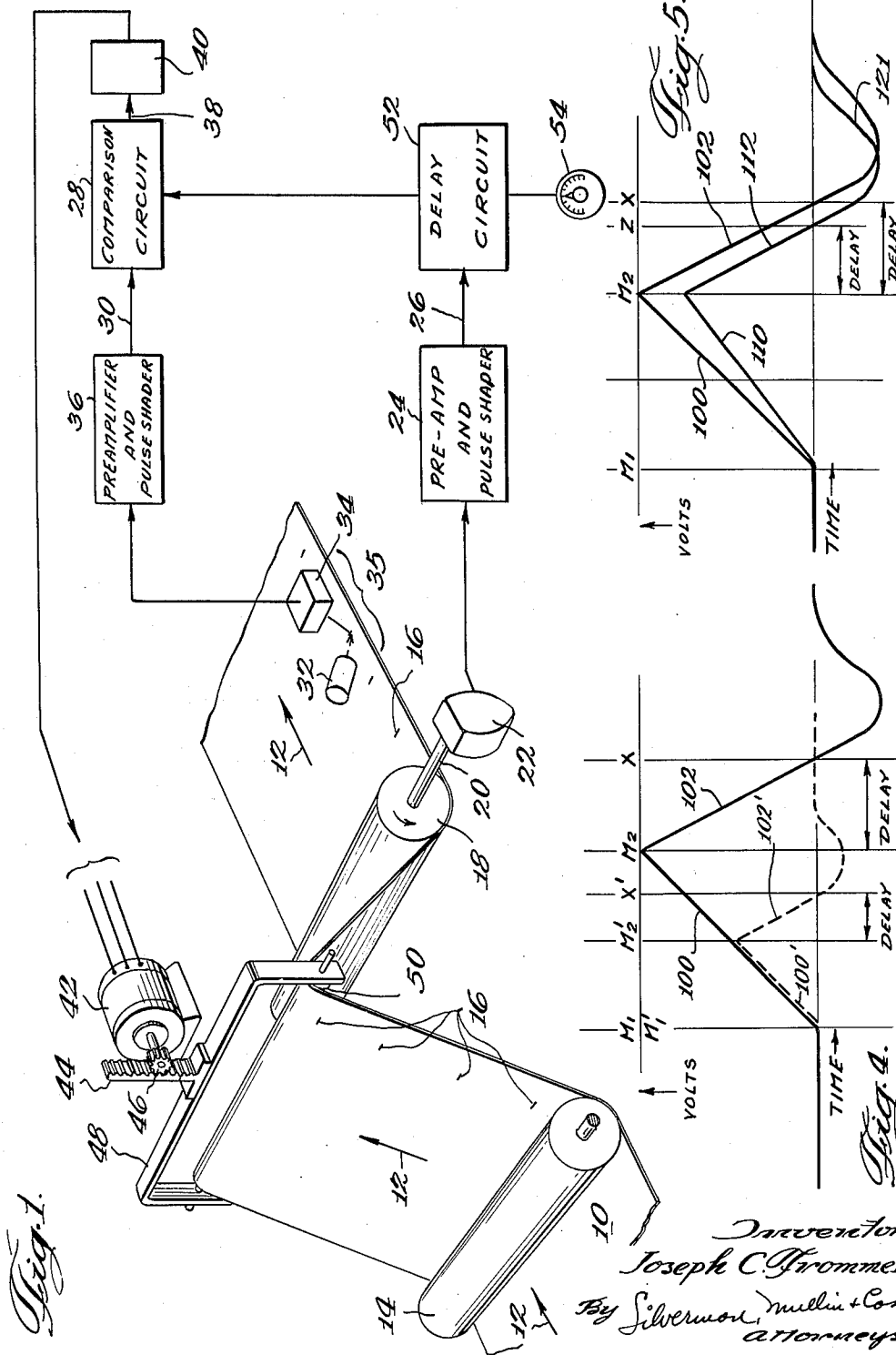
J. C. FROMMER

3,031,118

ADJUSTMENT CIRCUIT FOR REGISTRATION CONTROL DEVICE

Filed Nov. 4, 1958

3 Sheets-Sheet 1



April 24, 1962

J. C. FROMMER

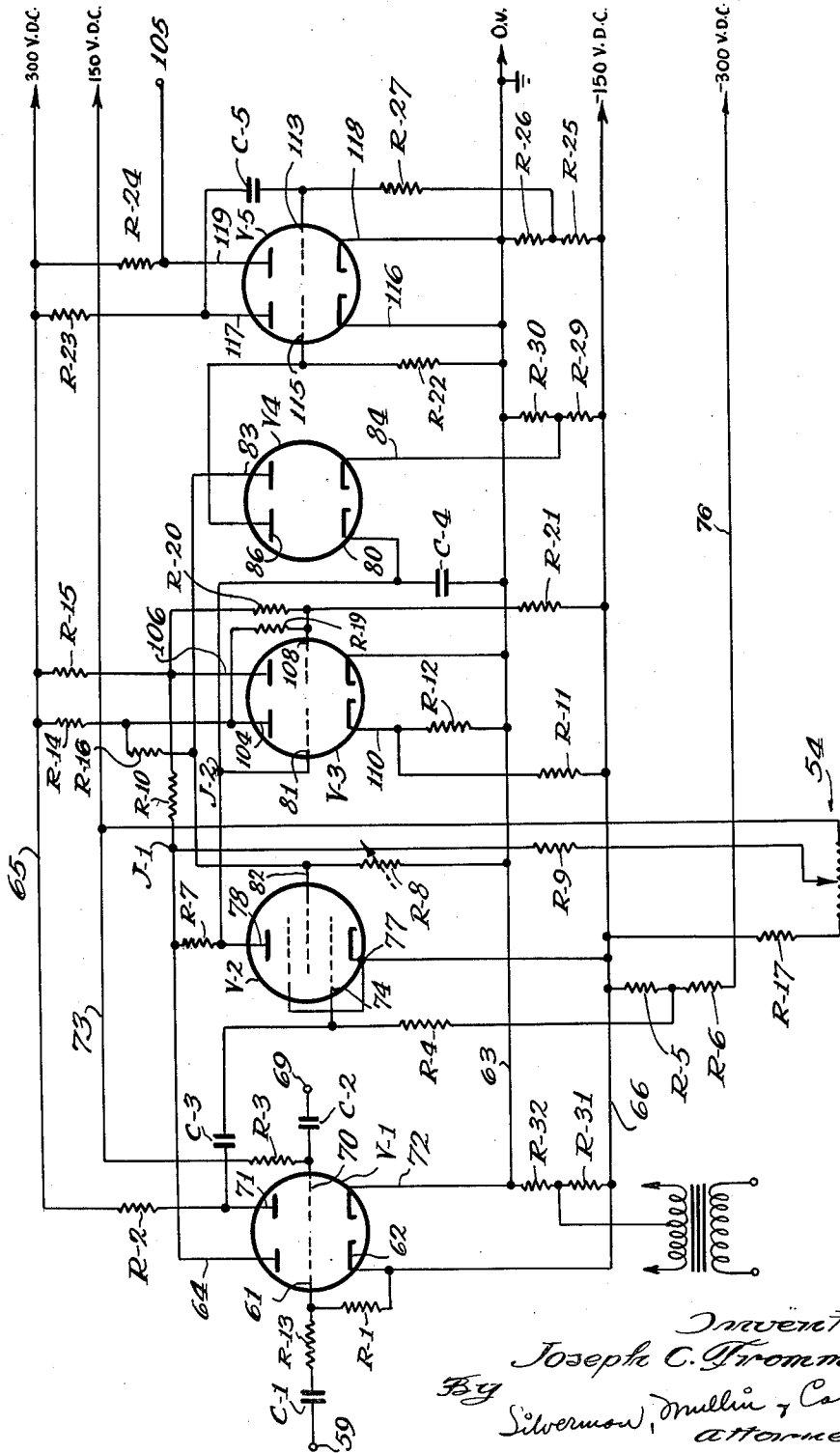
3,031,118

ADJUSTMENT CIRCUIT FOR REGISTRATION CONTROL DEVICE

Filed Nov. 4, 1958

3 Sheets-Sheet 2

Fig. 2.



Inventor
Joseph C. Frommer
By Silverman, Mullin & Carr
Attorneys

April 24, 1962

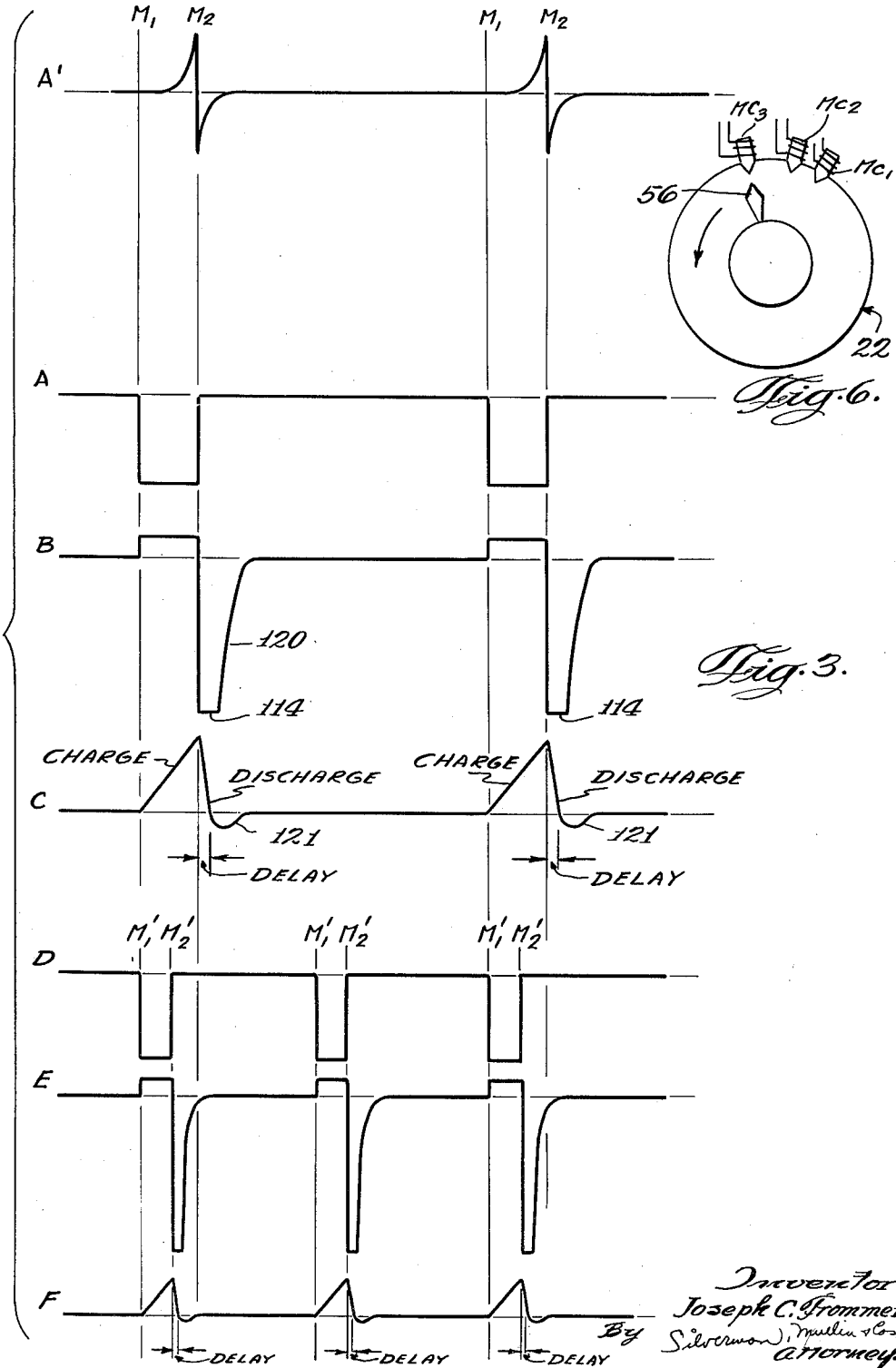
J. C. FROMMER

3,031,118

ADJUSTMENT CIRCUIT FOR REGISTRATION CONTROL DEVICE

Filed Nov. 4, 1958

3 Sheets-Sheet 3



1

3,031,118

ADJUSTMENT CIRCUIT FOR REGISTRATION
CONTROL DEVICE

Joseph C. Frommer, Cincinnati, Ohio, assignor to Hurlertron Incorporated, Danville, Ill., a corporation of Delaware

Filed Nov. 4, 1958, Ser. No. 771,821
27 Claims. (Cl. 226—28)

This invention relates generally to the control of registration of two or more operations being performed repeatedly and continuously upon a moving web, and more particularly relates to achieving a fine adjustment of the control through an electrical circuit whereby to obviate the need for adjusting certain signal producing means manually.

Such adjustment as contemplated by the use of the invention herein is exceedingly fine and enables a very high degree of accurate registration to be achieved by controlling the occurrence of certain electrical signals whose relationship determines the degree of registration. The invention is believed important because, in addition, the adjustments can be made without the need for stopping the movement of the web and without making physical changes in the position of any signal producing means whatsoever.

To appreciate and recognize the status and the nature of the invention herein, reference may be had to U.S. Patent 2,518,325 issued August 8, 1950 to S. C. Hurley, Jr. and to U.S. Patent 2,840,371 issued June 24, 1958 to the applicant herein, both of said patents being assigned to the same assignee as the application herein.

The subject matter of said patents comprises devices whose purpose it is to synchronize the performance of two consecutively executed operations upon a moving web in such a manner that notwithstanding the operations are performed at stations spaced along the length of the web, they occur in perfect registration with one another. The principal examples given in both of said patents concern high speed, multi-color printing presses in which it is desired that there be substantially perfect registration of consecutive impressions produced by consecutive printing cylinders or the like. In said patents there are described various circuits which function in accordance with a similar principle.

According to this principle, the first printing station which the web reaches during its travel applies a certain indicia upon the moving web along with the printed text or other matter. The indicia may be in the form of a small mark or series of marks recurrent along the length of the web. The web travels to the second printing station and the second impression, in another color, is applied to the web by the type or engraving or other means carried by the second printing cylinder, for example. In any event, the two impressions or printings are required to be in as perfect registration as possible, the end result of such registration being a realization of the effect desired from the original composition, both color-wise and impression-wise. The more accurate and precise the registration, the better the effect and the higher the quality of the printed result.

At the second station, secured to the shaft of the second printing cylinder or other rotational means which is applying the second impression, or at least rotatively coupled therewith, there is provided a magnetic member

2

often called a "flipper" in the art, which rotates past one or more electromagnetic poles whereby to generate current in the windings enwrapped about the said poles. The production of such current provides a signal with each passage of the flipper past one pole related substantially instantaneously with the rotation of the rotational means at the second printing station, such as for example, the second impression cylinder.

At another position along the web, which conveniently may be close to the second impression cylinder, there is positioned what is known in the art as a photoelectric scanner, including a source of illumination directed upon the web to illuminate the path of movement of the marks, and a photoresponsive device arranged to receive the reflection of the illumination from the web. Each time that the mark appears, the amount of reflection from the web is decreased during the time that the mark is passing, and the photo-responsive device, which may be a photoelectric tube or cell, will be affected. The effect may be a change in the current output of the tube. The reflection from the web will obviously be greater when there are no marks, and the amount of current produced through photosensitivity will substantially decrease with decrease in reflected illumination as the mark is passing.

In this manner, the output of the photo-responsive means is used to produce a scanner signal, which in effect is directly related to the impression upon the web applied at the first printing station, by the first impression cylinder.

The outputs of the two signal producing means, namely the structure comprising the flipper and poles, often called a magnetic timer, and the scanner are compared in a suitable device to provide an error signal. The comparison device is usually in the form of an electronic circuit which has the ability to complete the direction and amount of difference in the time occurrence of the two signals and provide a polarized output or an output in one of two different channels which is adapted to be applied to means physically operating upon the machine to bring the two printed impressions into registration.

In printing presses the correcting means usually comprise an idler roller between the two printing stations which is mounted in such a manner that its entire axis may be moved to change the distance that the web must travel in passing from the first impression cylinder to the second. Such a construction is shown in simplified diagrammatic manner in U.S. Patent 2,840,372 issued June 24, 1958 to R. J. Alhand and assigned to the assignee of this application. The mounting for the idler roller may be movable by means of a reversible electric motor which is connected to the output of the registration control circuit. The registration control circuit may operate into two relays, one of which will serve to apply power to the electric motor for translating the axis of the correction roller in one direction, and the other of which will serve to apply power to the electric motor for translating the axis of the correction roller in the opposite direction. Usually these directions are up and down. In moving the axis of the correction roller upward, the web length between printing stations is increased, and in moving the axis downward, the web length between printing stations is decreased. The registration control circuit will provide an error voltage which will energize one or the other of the output relays, or neither, depending upon the signals which are applied to the circuit.

Conveniently, when the printed impressions are in per-

fect registration, the signals are in perfect synchronism, and there is no error signal produced in the computer, so that the correcting means is not activated. The condition of perfect synchronism of the signals can be achieved, and has been achieved in many apparatuses in commercial use, through the physical adjustment of the positions of the scanner and magnetic timer, the one linearly relative to the length of the web, and/or the other circumferentially relative to the shaft of the second impression cylinder. Such adjustment is made until the signals are in perfect synchronism for the condition of perfect registration of the two consecutive impressions. The physical adjustment of the two signal producing means is a matter of changing fastening means, and this can be done usually with only a limited degree of accuracy. In most known installations, the position of the poles of the magnetic timer is changed, all of said poles for a given timer being mounted on a shoe which can be manually rotated arcuately relative to the axis of the cylinder which mounts the flipper. While this can be done while the press is operating, the achievement of perfect registration is a matter of trial and error involving repeated changes in the position of the shoe. Obviously, the scanner cannot be moved in its position while the press is in operation without danger to the operator.

Probably the primary object of the invention, which should be mentioned at this point, is to provide means whereby the initial disposition of the signal producing means may be coarsely set and fine adjustments made in the occurrence of the signal from said signal producing means electrically by means of a simple manual control. Such manual control may move a wiper or slider of a potentiometer, thus eliminating the need for fine adjustment of the physical position of one or the other of the signal producing means. Since the manually movable member, as contemplated by the invention, merely changes component values of an electrical circuit, it may be positioned immediately adjacent any position of the press where the results of printing impressions may be carefully observed for registration so that the observer himself may make the necessary fine adjustment. Thus, there is no need for establishing communication between the observer and an operator making the physical adjustments, as heretofore might have been required, and the amount of trial and error is kept to a bare minimum.

It should be understood that the need for making adjustments in the relative occurrence of the two signals obtains only when synchronism of the signals does not produce perfect registration. If the perfect registration condition thus described exists, there is no need to change the positions of the signal producing means, either physically or electrically through the use of the invention herein. The adjustment described will therefore usually take place only during the setting up of a project to be run on the press. The invention enables this to be done easier and faster. Once the desired conditions have been achieved for perfect registration, the position of the manual control of the invention is not changed, unless something unusual should occur during a run.

The invention will better be understood with a short explanation of what occurs to the printed impressions if the signal producing means are not perfectly positioned relative to the length of the web. If, for a condition of perfect registration, the signal from the magnetic timer occurs too soon, that is, before the occurrence of the signal from the scanner, the computer will produce an error signal and the correcting device will be driven to change the length of web subtended between printing stations until the signals occur in synchronism. The first impression would then be adjusted by the correcting means to occur sooner to force the electrical signals to be synchronized, irrespective of register conditions; and the final result would be that when the signals coincide, the second impression would be leading the first. The computer cannot be affected by the objective evidence

of registration since it is acted upon by the signal producing means irrespective of their relations to the impressions made at the printing stations, and if the signals are not coincident, the computer will strive to produce an error signal to make them so—irrespective of what happens to the registration of impressions.

The typical installation of apparatus of the type described in the patents referred to above includes means for shaping the signals to desired configurations prior to comparing the same, and various circuits are provided to achieve the desired wave shapes. In said Patents 2,518,325 and 2,840,371, the signals which are compared are first changed into substantially square waves by means of a so-called "flip-flop" circuit, and these square waves are conveniently related in time to the passage of the flipper between two poles of the magnetic timer. The invention herein preferably comprises a circuit which is electrically interposed between one of the signal producing means and the comparison device or computer, to change the position of the critical part of the signals along their time axis so that the result is a simulation of what would occur if the entire signal producing device were physically moved one way or the other. Thus, if the signal produced by the magnetic timer were delayed by the apparatus of the invention and the scanner signal were not, the effect would be the same if the magnetic timer had been physically changed, as for example, by moving the pole mounting shoe to give its signal later in time.

As stated above, the signal delay is obtained in this invention through the change of components of an electrical circuit. Delay of pulses in electrical circuits can be achieved in several ways, but the amount of delay which occurs in known circuits is related to the constants of the circuit, irrespective of the recurrence rate of the pulses, assuming that the amount of delay is always substantially less than the time between pulses. In other words, if a pulse is to be delayed by a given number of micro-seconds, through the use of a network of some known type, all pulses will be delayed by that time, irrespective of the rate at which the pulses occur. This, of course, is not practical for machines, the speed of which is not invariably constant, either by design or by chance, because in such machines the rate at which the pulses occur varies with the speed of the machine. For any given set of conditions, the amount of delay, measured in length of web represented by the delay, is constant. Therefore, the amount of delay measured in time varies, being a direct function of the speed of the machine, or press, in the case of the specific system discussed herein.

The invention herein utilizes an unobvious manner of providing for delay of an electrical signal such as produced in a device as described in the above patents, in which the delay of a given signal is inversely proportional to the speed of the press. In other words, the faster the press, the less the delay time, and vice versa.

The provision of means to cause this phenomenon forms an important object of the invention. The electrical circuit of the invention will provide a delay of a signal whose time duration is inversely proportional to the speed of the press. Thus, if at a web speed of 1500 feet per minute, a given condition of the apparatus provides for a delay of signal which corresponds to five-thousandths of an inch along the web, at 750 feet per minute the delay of signal must also provide the same linear delay. The press is going at a much slower rate of speed, however, and the actual time represented by the linear delay at the slower rate is twice the time represented by the linear delay at the faster speed. The delay in time, therefore, must be doubled when the speed of the press is halved. In addition, this same relationship, that is, the inverse proportion must be preserved for all speeds of the press. The invention herein accomplishes this.

Objects of the invention include the provision of novel

5

electronic circuitry of relative simplicity for accomplishing that which has been described above; the provision of means for producing a pulse or shaped signal from one of the signals produced by the signal producing means which will have an effective leading and trailing portion forming a constant angle so that the variation of the duration of the leading portion will result in proportional variation of the duration of the trailing portion; the provision of means to maintain the leading and trailing portions of said pulse substantially linear in order to preserve the constant angle, notwithstanding that the shape of at least one of said portions is caused by the flow of current in a condenser; the provision of an electronic circuit requiring no relays or the like, whereby the same may be readily installed by simple modification in many registration control apparatuses in use today.

The invention gives rise to many corollary advantages which stem from the ability of the press operator to cause the signals from the scanner and magnetic timer to coincide at registration of consecutive impressions, notwithstanding the fact that the physical positions of the scanner and magnetic timer are not perfectly adjusted. In setting up the press, a great deal of time need not be expended in locating the flipper with respect to the engraving or impression of the cylinder to the shaft of which the flipper is secured; likewise the location of the flipper relative to the poles of the magnetic timer need not be sought with precision. Pressmen are skilled sufficiently to make the adjustments within a fair degree of the range of an electrical circuit easily constructed in accordance with the invention. Because of this, the mounting of the flipper and the yoke or shoe of the magnetic timer may be considerably simplified.

Many other objects of the invention will become apparent to those who are skilled in this art, and while the apparatus will be described in connection with a printing press, it should be obvious that it is equally applicable to other systems in which there is a moving web upon which consecutive operations are to be performed. The structure itself is also capable of considerable variation from the specific examples shown in the drawings and described hereinafter.

In the following description, preferred embodiments are set forth in considerable detail as required by the patent laws, and the various circuits and diagrams illustrated in the drawings are explained in order to enable a complete and clear understanding of the invention to be had. In addition to exposition of the details of structure, the theory upon which the invention and operation thereof is based will be set forth, but only for the purpose of clarity and not by way of limitation, since the structure which is described and claimed hereinafter produces the functions which are necessary for the achievement of the objects described, and it is immaterial whether the theory or theories postulated are valid.

In the drawings:

FIG. 1 is a block diagram of a registration control system installed in a multiple impression printing press, showing the relationship of the invention and the other parts of the system.

FIG. 2 is a circuit diagram of apparatus embodying the invention and enabling the delay of a signal to simulate the effect of physically adjusting the position of the signal producing means.

FIG. 3 is a chart showing the time relationships between the various signals occurring in the circuit of FIG. 2, wave shapes designated A', A, B and C representing the wave shapes for a press speed half of the press speed for which the wave shapes designated D, E and F represent signals.

FIG. 4 is an enlarged view of the voltage wave shape of a signal appearing at a terminal of the condenser C-4 of FIG. 2, the wave shape being shown for two speeds of the press, one being twice the other.

FIG. 5 is a view similar to that of FIG. 4, but in this

6

view the press speed is constant, but two configurations of the signal are shown to illustrate the effect of relaying the signal through the use of the invention to simulate physically moving a signal producing device.

FIG. 6 is a diagrammatic view of a magnetic timer.

The invention, as alluded to above, is applied to a registration control system which is complete and will provide registration adjustment to overcome leading or lagging by one impression, providing the signal producing means are perfectly positioned relative to the respective impressions of the two printing stations or cylinders. In such a system, the output signals from the magnetic timer are usually amplified and shaped in some sort of pulse shaper to serve as gating means with respect to the signals which are received from the scanner. The scanner signals themselves may be pre-amplified and also shaped to certain required configurations.

Specifically, in the structures described in the patents referred to above, the output from the magnetic timer is applied to an electronic circuit whose output is substantially a square wave. The square wave is used to gate the circuit to provide the desired error voltage output. The trailing end of the square wave is that end with which control is achieved, since that end is the termination of the gate, and is used to operate upon the signal which is received from the scanner and its associated circuits.

The problem of providing a circuit in which by the simple adjustment of a manual control member, such as a small knob, the duration of the square wave can be varied is complicated by the requirement that in any event the duration of the square wave must be inversely proportional to the speed of the press. To meet this requirement, the amount of delay which is applied to the circuit must also be inversely proportional to the speed of the press irrespective of variation thereof.

In FIG. 1 there is illustrated diagrammatically a system of the type discussed herein showing how the invention is applied thereto. The reference character 10 designates a web, such as a web of paper passing through a high speed, multi-color printing press, the direction of movement being indicated by the arrows 12. The web is shown passing a first printing station at which there is located a first impression cylinder or roll 14 which applies a first impression of one color upon the web and also applies a small marginal mark 16 along the web recurrently, whose purpose it is to establish the position of the first impression on the web 10. The impression is not shown in the diagram since its presence is not needed to explain the invention.

Further along the web 10 there is a second printing station where a second impression cylinder or roll 18 applies a second imprinted impression (not shown) directly upon the first impression, and in a second color. Obviously the two impressions may comprise or be a part of a complete composite printing that eventually will be a magazine, newspaper, rotogravure section of a newspaper or the like, and in several colors. The two impressions must be in substantially perfect registration in order to produce the effect intended by the composer.

The shaft 20 of the second impression cylinder 18 is connected to the magnetic timer 22 which has previously been mentioned. The details of this device are well-known and hence are not elaborated upon here. Such a magnetic timer is shown diagrammatically in FIG. 6. The signal output from this device comprises the input to a pre-amplifier and pulse shaper 24. The pre-amplifier and pulse shaper 24 may take several different forms, but for the purpose of this invention, the output of this circuit at the point 26 preferably is a square wave. The square wave occurs in synchronism with the passage of the flipper past two poles of the magnetic timer 22 and in synchronism with the rotation of the cylinder 18 since the flipper (see 56 in FIG. 6) is mounted on the shaft 20. For convenience the block 24 will be referred to merely

as a pulse shaper, since the pre-amplifier is not essential. Conceivably the structure of the timer 22 may be modified such that the output may directly be a square wave signal or any suitable signal having two parts separated by a time depending on press speed. With this in mind, reference made in the claims to signal producing means will define either the magnetic timer 22 alone, in combination with a pre-amplifier and/or flip-flop circuit, or any device the output of which is a square wave or other two-part signal whose duration and occurrence are related to the rotation of the cylinder 18 and hence also related to the impression applied to the web 10 by said impression cylinder 18. In the discussion which follows, the signal related to the second impression cylinder is usually called the first signal (because the means producing the same are located forward of the web relative to the scanner).

The descriptive term "square wave" is a relative one, since it is rare that the square wave referred to is geometrically rectangular, as shown in FIG. 3. This is an idealized configuration, the actual shape varying substantially from the perfect form, but still providing the required functions by virtue of its form.

The signal which appears at 26 and which comprises a square wave is ordinarily applied to the comparison circuit or computer 28 where it is compared with another signal applied at the input 30. This latter signal is obtained directly from the web 10 itself. The marks 16 are illuminated by means of a source of light 32 and are reflected to a photo-responsive device 34 which includes a photoelectric cell or the like. The source of light 32, photo-responsive means 34, and other apparatus comprise the scanner 35, being practically always mounted in a single housing, including the optical system for focussing the light, etc. The passage of the marks 16 causes changes in the current flowing in the photo-sensitive device 34 which gives rise to signals which may be pre-amplified and shaped in the circuit 36 before being applied to the comparison circuit 28.

The output of the comparison circuit appears at 38 and is applied to means such as relay circuits which are symbolized generally by the block 40, producing an error voltage of one or another type to drive the motor 42. This motor is connected by suitable means such as a rack 44 and pinion 46 to a yoke or frame 48 which mounts an idler roller 50. The raising or lowering of the yoke or frame 48 through rotation of the motor 42 one direction or the other either increases or decreases the distance subtended along the web between the impression cylinders 14 and 18 and hence changes the conditions producing the error voltage. Any other means including differential gearing could be used to change this distance so long as it serves to adjust the positions of the impressions made by the respective cylinders relative one another.

The system of FIG. 1 as thus far described is well-known. The output of the pulse shaper 24 appearing at 26 is applied directly to the comparison circuit 28 in known structures, and when the signals from the scanner 35 and the magnetic timer 22 are in perfect synchronism, there will be no output signal appearing at 38, and the motor 42 will not be energized. Under these circumstances, ideally the two impressions applied at the printing stations by the cylinders 14 and 18 are in perfect registration. During setup, if this were found not to be the circumstance, either the physical relationship of the magnetic timer 22 with respect to the shaft 20, or the position of the scanner 35 with respect to the web 10, would be changed to cause perfect registration to occur.

The difficulties of accomplishing this for accuracies of the order of several thousandths of an inch have been described, and hence the circuit designated 52, the delay circuit, has been interposed between the pulse shaper 24 and the comparison circuit 28. A part of the delay circuit 52 includes a manual control 54 by means of which the linear amount of delay introduced can be varied.

For any given setting of 54, the linear delay will be constant, irrespective of the speed of the web 10. This delay circuit changes the time of arrival of the pulse from the magnetic timer thereby simulating a physical change in the position of the timer 22, but without the need for actually making such physical change. The change, as referred to, comprises a delay, which means that the initial adjustment of the timer and scanner should be made with the delay circuit 52 providing a delay equal to about half of its range, so that there is sufficient latitude for adjustment on both sides of the initial condition. This is merely a matter of technique in use, and each user may vary the same.

Attention is now invited to the circuit of FIG. 2 which is an embodiment of the invention comprising what has been termed the delay circuit having the manual control 54 of FIG. 1. The same circuit with slight modifications, as will be described, comprises a basic form of the invention without certain refinements which make for a better structure. In this circuit, the vacuum tubes or valves are designated by the reference characters V-1 to V-5, the resistors are designated by the characters R-1 to R-32, the capacitors are designated by the reference characters C-1 to C-5, and the potentials applied to the various parts of the circuit are marked by the value of the voltage for a typical structure. The voltage sources are not shown, since these may be any conventional means such as batteries, power supplies and the like and will probably be obtained from other parts of the system which require such potentials for their own purposes.

The magnetic timer 22, in conjunction with the pulse shaper 24 provides the square wave signal which is shown at A and again at D in FIG. 3. The signal is negative going and its leading edge occurring at the time M_1 is commenced when the flipper 56 which is secured to the shaft 20 (see FIG. 6) passes the pole or magnetic circuit MC_1 . The signal remains at a constant negative value during what is termed the lead inspection zone as the flipper 56 is passing to the next pole or magnetic circuit MC_2 at which time the signal becomes zero once more. This time is represented in FIG. 3 at A by the character M_2 which identifies the time as that when the pole MC_2 is passed. As for the wave form in FIG. 3 at D, the same zone is represented by the distance from M'_1 to M'_2 , the speed of the press being doubled and hence the length of the signal along the time axis being halved.

This signal A is applied at 59 through the coupling condenser C-1 and the resistor R-13 to the grid 61 of the left hand section of the twin triode V-1. The cathode 62 of this section of the tube (designated hereinafter V-1-L) is connected to a source of potential having a relatively substantial negative value, shown as -150 volts in FIG. 2. The plate 64 is connected to the junction J-1, which connects one terminal each of the resistors R-7, R-9 and R-10 for a purpose to be described. The grid 61 is connected to the cathode 62 by a grid leak resistor R-1 and hence, when there is no signal applied to the grid 61, said grid 61 and cathode 62 will be essentially at the same potential, and V-1-L will be conducting saturation current, whereby the plate 64 will be maintained at a voltage below zero, say -100 volts D.C., below ground.

When the negative going potential of the signal A of FIG. 3 is applied to the grid 61 driving the grid 61 negative, the left hand section V-1-L will be cut off, and the voltage on the plate 64 will consequently rise to a high potential which is a characteristic of the tube section V-1-L for an absence of plate current.

In the meantime, the right hand section of the tube V-1 (designated hereinafter V-1-R), has also been conducting saturation current, being connected to receive the input from the pulse shaper 24 which corresponds to an amplified signal which occurs when the flipper 56 passes the second pole MC_2 . This signal is applied to the terminal 69 through the coupling condenser C-2 to the grid

70 of V-1-R, the plate 71 being connected to high voltage B+ supply 65 through the dropping resistor R-2 and the cathode 72 being connected to ground 63. Note that the grid 70 is connected through a resistor R-3 to a high positive potential source 73 which may be of the order of 150 volts D.C., and hence it normally draws grid current. Because of this the tube section V-1-R is conducting saturation current, which places the plate 71 at a relatively low potential.

The pentode V-2 has its grid 74 connected to the plate 71 of V-1-R through a coupling condenser C-3 and to the center tap of the voltage divider R-5, R-6 connected between two points of negative potential, shown at 66 and 76 as -150 volts D.C. and -300 volts D.C. respectively. Thus, with the grid 74 of the pentode V-2 very negative with respect to the cathode 77, the pentode V-2 will be cut off so long as there is no signal on the grid 74. The plate 78 of the tube V-2 is connected to the plate 64 of V-1-L through the resistor R-7, but the plate 78 is also connected to the upper electrode of the storage condenser C-4 at the junction J-2, to the cathode 80 of the left hand section of the dual diode tube V-4 (hereinafter called V-4-L), and to the grid 81 of the left hand section of the twin triode V-3 (said left hand section hereinafter called V-3-L).

The pentode V-2 has its screen grid 82 connected through the resistor R-8 to ground which actually is at 150 volts D.C. above its cathode 77 which, it will be noted from FIG. 2, is connected to the point of negative potential 66, shown to be at -150 volts D.C. The voltage of the screen grid 82, however, is limited by the plate 83 of the right hand section V-4-R, the cathode 84 of this latter tube section being connected to the center tap of the voltage divider R-29, R-30 which extends between ground 63 and a substantial negative D.C. potential, such as the point 66 which is maintained at about -150 volts D.C.

The signal from the pole MC₂ which has been amplified appears somewhat as shown at A' in FIG. 3 and, as will be seen from an examination of the circuit, its positive going portion will have no effect upon the tube V-2 since the plate 71 of V-1-R will continue to be low in potential, the right hand section V-1-R being in saturation. As for the negative going portion however, this will serve to cut off the right hand section V-1-R, raise the potential of the plate 71, and will cause the tube V-2 to conduct a current defined essentially by the resistor R-8 for the duration of the negative going portion of the signal A'.

Considering now the signal A which was applied to the tube section V-1-L as shown in FIG. 3, when this signal goes negative and the tube section is cut off, the condenser C-4 will commence to charge positively through the high ohmage resistor R-7 (which may be of the order of 3 megohms). The current path is from the junction J-1 through the resistor R-7 to the junction J-2 which is common with the upper electrode of the condenser C-4. This charge occurs at a relatively slow rate, but is linear, as will be brought out shortly, notwithstanding that the normal condenser charge characteristic is asymptotic. During this charging period, it will be recalled, the tube V-2 is not conducting until the signal A' became negative, and hence has no effect upon the charge characteristic (see the wave shapes C of FIG. 3).

As soon as the tube V-2 becomes conducting, at the time M₂, the flow of current through the tube V-2 will be the only factor limiting discharge of the condenser C-4 and hence the discharge will occur at a very high rate, as the constant plate current of the now conductive tube V-2. This may be considered a negative charging of the condenser, and it is quite linear also.

It is desirable for the purposes of this invention that the two portions of the condenser potential signal C of FIG. 3 be linear, and the invention includes means to assure this. Two different structures which accomplish

this with respect to the charge portion of the wave form will be described, one being a simpler version than the other.

The condenser C-4 will continue to discharge along the right hand portion of the triangular shaped wave shown at C in FIG. 3 until it falls below zero. Thereafter, it will make the grid 115 of the left hand section of the twin triode V-5 (said left hand section being hereinafter designated V-5-L) negative through V-4-L. This signal will be amplified in V-5-L and appear at the plate 117, applied through the coupling capacitor C-5 to the grid 113 and provide a signal on the plate 119 of V-5-R. The output signal is thus delayed from the occurrence of M₂ as shown in FIG. 3 for the time that was required for the condenser C-4 to discharge to zero.

In other words, the time at which the characteristic C intersects the base line shown will occur after the time M₂ which corresponds to a certain delay. This, in turn, depends upon the slopes of the charge and discharge portions of the characteristic. The closer these slopes are controlled to linear the more readily will the apparatus provide a signal delay which varies inversely as the speed of the printing press. Varying the constants of the charge circuit will enable the slope to be changed, and if the circuit of discharge has not been changed, the delay will be changed by a predetermined amount. Furthermore, decreasing the time of the pulse between M₁ and M₂ as would be occasioned by an increase in the speed of the press, would decrease the delay proportionally, as may be readily seen from the geometry of the wave shapes.

This latter occurrence is illustrated in FIG. 3 at D, E and F. These latter waves are identical to A, B and C respectively except that the press speed has been doubled. Note that the voltages and currents of the input signals have not been changed in amplitude but the durations of the pulses have been halved. Because the charging of the condenser C-4 lasted for only half of the time in F as in the case of C in FIG. 3, C-4 is charged to only half the potential of C. The discharge with the same current thus lasts only half as long and therefore the triangular wave shape subtends precisely half the distance on the base line. This results in a halving of the delay.

FIG. 4 demonstrates this in an enlarged view. The charge of the condenser C-4 commences at a given speed of the press along the line 100 at the time M₁ and follows the slope determined by the constants of the circuit (and other factors which will be described) which is preferably linear. M₁ coincides with the flipper meeting the pole MC₁. Thereafter the discharge occurs along a preferably linear line 102 commencing at the point in time M₂ which is when the flipper meets the pole MC₂ and crosses the base line (zero volts) at a time X. The delay produced by the delay circuit is thus equal to the time elapsed between M₂ and X.

The broken line curve of FIG. 4 is one which represents the charge and discharge of the condenser C-4 at a speed of the press which is exactly two times the speed for the solid line curve of FIG. 4. The circuit is identical in all respects, and no changes have been made in the circuit constants. In this case, choosing the starting time of charge as M₁' coinciding on the figure with M₁, the charge characteristic 100' follows precisely the same line as the charge line 100 because the circuit and constants are identical. When M₂' time is reached, however, the flipper 56 has reached the pole MC₂. The elapsed time from M₁' to M₂' is exactly half the elapsed time from M₁ to M₂. From the geometry of the two wave forms, obviously the length of the line 100' is half the length of the line 100. Discharge now commences along the line 102' and the slope of 102' is exactly the same as the slope of 102 and hence, the characteristic is parallel therewith. Thus, the intersection X' of 102' with the zero base line provides a delay M₂' to

X' which is half of the delay time M_2 to X. So long as substantial linearity is preserved, this will be true for any and all speeds of the web 10, and in effect what has been accomplished has been to provide an angular delay (insofar as the signal from the cylinder 18 is concerned) which is independent of the speed of the press.

As previously stated, when the left hand section V-1-L and the tube V-2 are cut off, the condenser C-4 is being charged positively through the high ohmage resistor R-7. This charging characteristic will depend upon the voltage of the junction point J-1 which may be constant or variable during the charging period. The latter circumstance is preferred, and the presence of the tube V-3 enables this to be accomplished in a manner to be described. The invention can be satisfactorily practiced, however, by maintaining the junction point J-1 at a relatively high voltage so that the charging characteristic operates only upon the very beginning of the asymptotic characteristic obtained by charging from a fixed potential. The voltage of this point is also manually adjusted by changing the position of the slider of the potentiometer 54 which is the same as the manual control shown in FIG. 1. The potentiometer 54 is a part of a voltage divider which includes the resistor R-17 and extends between two potential points 66 and 73 which may be at different voltages. In the preferred embodiment which uses the tube V-3, these voltages are -150 volts D.C. and +150 volts D.C. respectively, giving a spread of 300 volts. The potential is applied through a resistor R-9 to the junction point J-1.

Since the delay which is applied to the signal from the magnetic timer is measured by the instant that the discharge characteristic carries the diode section V-4-L negative, the exact time that this will occur depends upon the characteristics of the tube V-4. There may be a slightly varying contact potential existing in tube V-4 such that the zero condition is not precisely defined. Unless the amplitude of the charge and discharge characteristic is substantially greater than this very small potential, the small contact potential may become a significant error. To prevent this, the charge and discharge slopes are preferably made very steep, and in the case of the embodiment of the invention which omits the tube V-3, this can be done by choosing the voltage of the point J-1 to be very high, say of the order of 1000 or more volts D.C. The charging rate will thus be increased along with the slope. The charging rate can also be increased by decreasing the ohmage of the resistor R-7, but this may be done at a sacrifice of linearity, and hence, the use of a higher voltage is preferable.

Summarizing the operation of the embodiment in which the voltage of the point J-1 is fixed during discharge, prior to the time M_1 the tube section V-1-L is conducting saturation current; the tube V-2 is cut off; the condenser C-4 has zero potential and no charge across its electrodes; there is no signal being applied to the tube section V-1-R, and it is conducting saturation current. The manually controlled potentiometer 54 has been adjusted to a position representing a given delay, the dial of this control being calibrated in thousandths of an inch linear delay or the like. V-1-L keeps the junction point J-1 below zero as needed, and there will be no effect upon the condenser C-4 because V-4-L will keep it at essentially zero voltage.

Continuing with the summary of the simplified embodiment, after the arrival of the negative going signal A, between the time M_1 and the time M_2 the tube section V-1 is cut off and presents substantially an infinite impedance to the circuit, so that C-4 commences to charge toward the voltage of the point J-1. During this period, V-1-R is still conducting saturation current and V-2 is still cut off. The voltage of the point J-1 is controlled exclusively by the position of the slider of the potentiometer 54, this being a circuit which excludes the tube V-3.

When time M_2 is reached, the tube section V-1-R

gets the negative signal A', makes the plate 71 positive, applies a signal through C-3 which causes grid 74 to become positive, and V-2 conducts such current as permitted by the screen 82 and controlled by the screen resistor R-8. This is a constant current. The condenser C-4 discharges as the plate current of the tube V-2, making the condenser more negative. During this period of time V-1-L may or may not be still cut off because the plate current of V-2 is so great compared to the current which could flow through R-7 as to completely control the current flow into C-4.

When the voltage on the condenser C-4 drops to zero (X in FIG. 4), the diode section V-4-L conducts, and as soon as current flows through the resistor R-22, the tube section V-5-L amplifies the resulting signal, which is quite small, as does the section V-5-R and sends the resulting output into the comparison circuit to gate the signal from the scanner. The negative portion of the characteristic is the trigger for the scanner signal and hence since it occurs a delayed period after the time M_2 , the effect will be as though the signal from the magnetic timer were delayed.

Even a high voltage applied to the point J-1 will produce a typical condenser discharge characteristic which is almost linear at its beginning, but is still logarithmic in nature. The greatest accuracy for the requirements of the invention is achieved when the charge portion 100 of the curve is practically perfectly linear. This is accomplished through the use of the novel circuit utilizing the tube V-3 in the manner described immediately below.

A voltage indicative of the voltage of the condenser C-4 is obtained on the plate 104 of the left hand section V-3-L of the tube V-3. This plate 104, it will be noted, is connected through the load resistor R-14 to the high voltage supply 65. The voltage of 104 is achieved through the effect thereon of the grid 81 which in turn is connected to the condenser C-4. There is a network R-19, R-20 and R-21 between the plate 104, plate 106, grid 108 and the negative potential point 66 which is at 150 volts D.C. below ground. This network causes a state of equilibrium to exist in which the voltage on the plate 106 of V-3-R is essentially opposite to the voltage on the plate 104 of V-3-L and therefore similar to the voltage on the grid 81 of V-3-L but displaced from it by a constant D.C. value.

Consider a condition in which the grid 81 of V-3-L is at zero potential. Under this condition, the voltage on the cathode 110 will be at say plus 14 volts D.C. The voltage at the plate 104 may be at about plus 230 volts D.C. When the condenser C-4 commences to charge, it charges toward a potential which exists at the upper end of the resistor R-7 at the junction point J-1, namely, the potential of the plate 64 of V-1-L. As the voltage on C-4 rises in value, the grid 81 must also rise, the plate 104 decreases in voltage, the grid 108 decreases in potential because of the connection with the plate 104 through the resistor R-19, as a result of which the plate 106 rises in potential. Since the upper end of the resistor R-7 is also tied to the plate 106 through the resistor R-10 which is part of a voltage divider including the resistors R-9 and R-10, the upper end of R-7, that is point J-1 will assume a voltage which depends not only upon the position of the wiper of potentiometer 54 but also depends upon the voltage of the plate 106. In this way, adjustment of the potentiometer 54 varies the value of the D.C. potential by which the junction point J-1 is kept above the potential of C-4, this point rising in potential as the condenser charges so that the slope of the charge curve is linear because the voltage toward which the condenser charges is theoretically infinitely high.

The voltage on the plate 106 is controlled by the network R-19, R-20, R-21 and R-15 which may be chosen so that for each volt of rise of the potential of the condenser C-4, the plate 106 rises 2 volts, and through voltage divider action of R-9, R-10, the point J-1 rises 1 volt.

The slope of the curve of the condenser charge under these circumstances is controlled by the fixed D.C. value set by the potentiometer 54 and the capacitance of the capacitor C-4, and hence, the potentiometer controls the amount of delay time enabling same to be varied at will. The resistor R-17 adjusts the range of the potentiometer 54 to zero differential in the left extreme position of the wiper.

The effect of varying the potentiometer 54 is appreciated by considering the terminals of the potentiometer circuit. The right hand terminal of the potentiometer 54 is connected to 73 which is at +150 volts D.C., and the other terminal is connected through the resistor R-17 to -150 volts D.C., so that there is a total of 300 volts across the potentiometer 54 and the resistor R-17 combined. This voltage will be divided according to the resistances of the respective elements, and in one successful example, the ratio of resistances of 54 to R-17 was 30 to 4.7 so that the voltage of the slider could be adjusted from -110 volts D.C. to +150 volts D.C. This voltage, modified by the effect of voltage divider R-9, R-10 is applied to the upper end of R-7 and controls the slope of the charge curve. Obviously, the slope will be steepest when the slider is at the right hand terminal of the potentiometer 54, and will give the maximum delay. The minimum delay will occur when the voltage toward which the condenser C-4 charges is so low that the slope of the charge curve will be practically zero, and the discharge curve will intersect the base line substantially at the time M_2 . This will be a nullifying of the effect of the circuit, and will simulate the application of the square wave of the input directly to the output terminal 105. Between these two extremes the delay is adjustable as demonstrated in FIG. 5.

In FIG. 5 there are illustrated two wave shapes, one of which is substantially the same as the signal designated 100 and 102 in FIG. 4, these characters representing the charge and discharge of the condenser C-4. The other signal illustrated has a charge characteristic which is designated 110, of lesser slope than the charge line 100, and a discharge line 112 which is parallel with the charge line 102 and will intersect the base line at time z instead of time x . Consequently, the resulting delay will be $M_2 - z$, substantially less than $M_2 - x$, namely, in the proportion of slopes of 100 and 110. It will be recognized that the distance between M_1 and M_2 for both waves is the same, and this represents therefore a constant speed of the press. This diagram illustrates the manner in which the movement of the slider of the potentiometer 54 will change the delay.

The discharge curve 102 represents the discharge of the condenser C-4. This commences immediately after there is a negative excursion of the signal A' at M_2 during conduction of tube V-2. The plate current of V-2 is kept substantially constant, having the screen 82 tied through R-8 to the line 63, which is 150 volts D.C. above cathode 77. The resistor R-16 from screen grid 82 to plate 104 of V-3-L corrects secondary effects from changing plate voltage since voltage of plate 104 varies in a direction opposite the voltage of plate 78. Because of this the discharge will also occur at a linear rate.

The charge and discharge currents of the condenser C-4 are shown at B and E in FIG. 3 for two different speeds. Note that the negative discharge current shown at 114, continues at a constant value for sufficient time for the delay to occur. The delay will result in the discharge of the condenser C-4 long enough to bring C-4 to zero, referred to hereinabove as the intersection of the discharge line of signals C or F of FIG. 3 with the base line. When this occurs, the left hand section of the tube V-4 commences to conduct from cathode 80 to plate 86, and the grid 115 of tube V-5 drops below zero cutting off the flow of current from the cathode 116 to plate 117, raising the grid 113 by way of the coupling capacitor C-5, and producing a triggering signal in the right

hand section of tube V-5 which is applied through the terminal 105 to the comparison circuit 28. The output circuit is taken from the terminal 105 to ground, the terminal 105 being connected directly to the plate 119 of V-5-R. This delayed signal can be used in a manner described in said previously mentioned patents. The important portion of the signal is the negative going discharge portion 121 which is used for gating or triggering or controlling relative to signals obtained from the scanner 35.

The shape of the charge-discharge characteristic will determine the delay produced, and this can be changed in several different ways. The slope of the charge curve is changed by the manual change of the position of the potentiometer 54 which changes the voltage of the point J-1 toward which the charge occurs (of course with the added voltage when the tube V-3 is used in the circuit); the slope of the charge curve can also be changed by using different values of the components involved, such as for example, the resistance of the resistor R-7 or the capacitance of the capacitor C-4; the slope of the discharge curve can be changed by changing the circuit constants of the circuit of tube V-3, such as the value of resistor R-8. The simple manual variation of the resistance of the potentiometer 54 provides the easiest control of delay by varying only upon the slope of the charge characteristic 100.

After the condenser C-4 has discharged and returns to zero, as indicated by the curved line 121, the tube V-5 returns to its stationary condition. Until the next signal from the magnetic timer occurs, the section V-1-R conducts saturation current and prevents C-4 from charging with positive current. The tube section V-4-L prevents C-4 from assuming a negative potential so that the new cycle will always find C-4 at zero potential, giving accuracy to the control of delay.

The tube section V-4-R controls the potential of the screen grid 82 during the period that V-2 is cut off. Such variations that may occur in the voltage of the plate 78 of V-2 during charging of C-4 can be compensated for by means of R-16 which extends between the screen grid 82 and the plate 104 of V-3-L, the latter being a point whose potential varies inversely with the voltage on the plate 78, as previously mentioned.

The functions of circuit components illustrated in the circuit but not specifically mentioned are believed obvious. These include plate load resistors, voltage dividing resistors, balancing resistors, and the like. The circuit constants listed below will emphasize the nature of the component. The important networks can be computed by usual network techniques which need not be mentioned here to provide any desired ratios. The changes in voltage of the plate 106, condenser C-4 and the junction J-1 mentioned in the specification above were obtained with the networks involved having the values set forth in the following details of a practical successfully operated structure:

R-1	-----megohms---	2.2
2	-----do-----	1.0
3	-----do-----	1.5
4	-----do-----	2.2
5	-----do-----	.47
6	-----do-----	.47
7	-----do-----	3.3
8	-----do-----	3.3
9	-----do-----	3.3
10	-----do-----	3.3
11	-----do-----	1.0
12	-----do-----	.22
13	-----do-----	1.0
14	-----do-----	.22
15	-----do-----	.15
16	-----do-----	44.0
17	-----do-----	.047

19	-----	megohms	4.0
20	-----	do	18.0
21	-----	do	2.2
22	-----	do	.01
23	-----	do	.47
24	-----	do	10.0
25	-----	do	4.7
26	-----	do	.1
27	-----	do	2.2
29	-----	do	.047
30	-----	do	.47
31	-----	do	1.0
32	-----	do	1.0
	Potentiometer 54	-----	.3
	Coupling capacitors C-1, C-2, C-3	microfarad	.1
	Storage capacitor C-4	-----	.01
	Coupling capacitor C-5	-----	.01
	Tube V-1	-----	12AT7
	Tube V-2	-----	6AU6
	Tube V-3	-----	12AU7
	Tube V-4	-----	6AL5
	Tube V-5	-----	12AT7

None of the filaments are shown, but all are supplied from a suitable transformer shown in the lower left hand corner of FIG. 2 with either 6 volts or 12 volts, as required.

It will be seen that the various tubes have basic functions which, if pointed out, may aid in an understanding of the invention. V-1-L is a gating tube section to incapacitate the effect of resistors R-7-, R-9, R-10 until the first signal arrives. V-1-R is a control section to program the operation of the tube V-2, so that the discharge commences at the proper time M₂. V-2, of course, is the discharge path for condenser C-4. V-3 is the tube which provides the constant D.C. voltage above the potential of C-4 toward which the condenser C-4 charges, so that the charge is linear, and is not essential to a basic structure, but is in a preferred embodiment. V-4-L is an isolating section between the condenser C-4 and the amplifier tube V-5. V-4-R is a limiter for screen grid 82 during the time V-2 is cut off.

The operation of the delay circuit described depends upon two signals. The charge portion from M₁ to M₂ depends upon the square wave signal A which is derived from a flip-flop or other wave-shaping circuit. The beginning of the charge occurs at time M₁ simultaneously with the negative excursion of the square wave and the end occurs at M₂. This end is simultaneous with the end of the negative square wave A, but the tube V-2 which controls discharge is ungated by the section V-1-R which is cut off by the negative excursion of the signal A' that is injected at 69. This latter signal A' is derived from the magnetic timer 22 directly or from the flip-flop circuit.

The delay described is the delay of the end of the magnetic timer signal, namely, delay of the time that the signal becomes zero.

The signal from the scanner 35 could be delayed in a similar circuit. This is derived from photo-electric means. For example, the charge portion of the circuit could be gated by a photoelectric signal obtained from the beginning of a relatively long mark 16 and the discharge gated by a second photoelectric signal obtained by the same photo-responsive cell from the end of the mark 16. An alternative structure would have two cells displaced from one another, both influenced by the arrival or departure of the mark.

The invention could also be practiced using the magnetic signal to start charge and a photoelectric signal to start discharge, or vice versa.

Some reference should be made to several of the variations which are capable of being made in accordance with the teachings of the invention and without in any way departing from the spirit or scope of the inven-

tion. As an example, the output signal represented by the charge and discharge characteristics of the condenser C-4 should be examined. The specification has described means for changing the slope of the charge line through the use of the variable potentiometer 54 to achieve the variation of delay in the signal, represented by the time between M₂ and complete discharge of the condenser C-4. This is M₂-X in FIGS. 4 and 5. The same effect can be achieved through variation in the slope of the discharge line 102 maintaining the slope of the charge line 100 constant. One way of varying the slope of the discharge line would be to vary the resistance of the resistor R-8 and this has been indicated in FIG. 2 by showing a broken line arrow through R-8, the arrow and resistor being the symbol of a variable resistor, and the same being broken to show that it is an alternate variation of the preferred embodiment.

In the claims which appear hereinafter, reference is at times made to a "first signal" and a "second signal." In the specification above, two separate signals were applied to the respective sections of the tube V-1 at the terminals 59 and 69 respectively to provide gating for the charge and discharge circuits of the condenser C-4. These signals are designated A and A', the signal A being a square wave and the signal A' being a pulse obtained from the magnetic timer circuit MC₂. The signal A' was shown to coincide in time with the trailing edge of the square wave signal A. In the practical example, the pulses obtained when the flipper 56 passes the two poles of MC₁ and MC₂ are used to drive a flip-flop circuit which will provide the square wave A so that the signals A and A' are actually available.

The invention contemplates that the tube sections V-1-L and V-1-R will receive signals at the times M₁ and M₂ which are either provided by separate signal producing means; which are provided by a single signal producing means which generates two signals in and of itself; or which are provided by a single signal such as a square wave similar to signal A which is applied at terminal 59, while simultaneously being applied at terminal 69, but perhaps after first being shaped or modified to a condition which produces the desired function at 69. By this it is meant that if the terminal 69 requires a negative going signal or any other kind of signal, the shaping or modification can be done using suitable electronic and/or electrical elements such as other vacuum tubes, diodes, pulse-shaping networks and the like. Thus, where the language refers to first and second signals, it is intended to include signals or parts of the same signal, or having significant characteristics related to a signal or signals to provide the necessary gating functions at M₁ and M₂ regardless of how made.

The invention as described above has been applied to a machine, such as a printing press, in which a flexible web moves relative to a station performing an operation thereof related in time to the performance of a prior act, such as for example, a prior operation on the same web. The invention does not necessarily require that there be a web moving relative to the second station. The operation performed at the second station could be punching, forming, capping, printing, applying some article to another, or almost any other type of activity the time of occurrence of which can be related to the speed at which the object or objects upon which the operation is performed reach the station, in accordance with the invention.

It is desired therefore to be limited only by the scope of the invention as defined in the appended claims, considered in the light of the broadest range of equivalents which the prior art indicates.

What it is desired to secure by Letters Patent of the United States is:

1. In a system in which an object moving relative to a signal producing arrangement controls said arrangement to provide, respectively, a first signal and a second signal separate one from the other by a period of time, the length

of which time is inversely proportional to the speed of movement of said object; means for producing a third signal at a time displaced from the time of occurrence of the second signal output by a predetermined delay varying linearly with the speed of movement of said object, said third signal producing means comprising, a capacitive charging circuit normally inoperative, means connected in said charging circuit and gated by the first signal to render the said charging circuit operative, and a discharge circuit connected with said charging circuit and normally inoperative but including means rendering the discharge circuit operative responsive to the occurrence of the second signal to discharge the charging circuit, the substantial discharge of said capacitance circuit forming said third signal.

2. A structure as claimed in claim 1 in which means are provided to render the charge and discharge characteristics each substantially linear.

3. A structure as claimed in claim 1 in which means are provided to render the charge and discharge currents of said capacitive charging circuit substantially constant.

4. A structure as claimed in claim 1 in which means are provided establishing a potential point toward which said charging circuit charges when rendered operative and said charging circuit includes means raising said potential point by a constant additional potential above the charging circuit voltage during charging.

5. Structure as claimed in claim 1 in which means are provided establishing a potential point toward which said charging circuit charges when rendered operative, said means connected in the charging circuit comprises an electronic tube having at least a plate and a control electrode, said potential point is connected to said plate, a potential source is connected to said point, and said charging circuit includes a capacitor also connected to said potential point, the tube being maintained conducting prior to the occurrence of the first signal whereby to maintain said point at a constant low voltage and prevent charging of said capacitor, but rendered non-conducting by the said first signal to permit the potential source to establish a high potential at said point and the capacitor to charge toward said potential, the signal producing means being connected to apply the said first signal to said control electrode.

6. Structure as claimed in claim 1 in which said means in the discharge circuit includes an electronic tube having at least a plate and control electrode, and said charge circuit including a capacitor connected also to said plate, the electronic tube being normally non-conducting whereby to have substantially no effect during charging of said charging circuit, and being rendered conducting by the second signal whereby to discharge the capacitor through said tube thereafter, said signal producing means being connected to apply said second signal to said control electrode.

7. A structure as claimed in claim 1 in which means are provided establishing a potential point toward which said charging circuit charges when rendered operative and there is a source of potential and an impedance network including a variable impedance element connected between said potential point and said source whereby variation of said impedance element will vary the potential of said point and hence the rate of charge of said capacitive charging circuit which will in turn vary the time required for discharge thereof.

8. A structure as claimed in claim 7 in which said network includes a voltage divider having opposite ends thereof connected to terminals of said source, one source terminal being variable to increase its voltage in predetermined ratio relative to the voltage of said capacitive charging circuit during charging, whereby to continuously raise the voltage of said potential point by a predetermined value exceeding the voltage of said charging circuit during charging and render the charging characteristic substantially linear.

9. A structure as claimed in claim 8 in which an amplifier is connected to said one source terminal having a signal from said capacitive charging circuit connected as its input whereby the output follows the input signal.

10. A web system in which the web moves relative to two stations at which operations are respectively performed, said operations adapted to be performed in registration, said system including signal producing means providing two signals related respectively to the operations performed at each station, one of said signals having two parts spaced by a time inversely proportional to the speed of the web, a comparison circuit having said signals applied thereto for comparing the two signals to produce an error signal if the two signals are not properly related for registration; means for delaying said second part of said one of the signals applied to said comparison circuit whereby to vary the error signal, said delay being related to a given length of said web irrespective of the speed of the web and arranged to vary in accordance with the web speed, comprising, a capacitive charge and discharge circuit including a condenser normally at zero charge potential, a source of potential including points of upper and lower value, a junction point adapted to be placed at a positive potential, an impedance element connected between said condenser and said junction point and the condenser adapted to be charged toward the potential of said junction point, an impedance network including a manually adjustable impedance between said points of said source and said junction point adapted to apply a positive potential to said junction point, a discharge circuit connected to said condenser, means normally maintaining said junction at a low potential to prevent charging of said condenser, means normally maintaining said discharge circuit incapacitated, means for applying said first part of said one signal to said circuit to render said charging preventing means inoperative whereby said condenser charges after said first part has been so applied, and means for applying said second part to said incapacitating means to render said incapacitating means inoperative whereby to cause discharge of said condenser through said discharge circuit and thereby delay the discharge of said condenser to vary said error signal for said length of web moved between the occurrence of the two parts of said one signal in accordance with the speed of said web.

11. A structure as claimed in claim 10 in which means are provided to maintain said junction point at a fixed voltage above the voltage of the condenser at any time during the charging of said condenser.

12. A structure as claimed in claim 10 in which means are provided to maintain said junction point at a fixed voltage above the voltage of the condenser at any time during the charging of said condenser, comprising, a ratio network controlled by the potential of said condenser.

13. A structure as claimed in claim 10 in which means are provided to maintain said junction point at a fixed voltage above the voltage of the condenser at any time during the charging of said condenser, comprising an electronic amplifier having a plate output terminal and having the said condenser connected to its input whereby the output follows the input by a predetermined constant increased voltage, and the said output terminal is connected to said junction point.

14. A structure as claimed in claim 10 in which said discharge circuit comprises a screen-grid controlled electronic tube.

15. A structure as claimed in claim 14 in which said screen-grid controlled tube has an element connected to said screen-grid which maintains current of said tube at a constant value, irrespective of the voltage across said latter tube.

16. A structure as claimed in claim 14 in which means are provided limiting the voltage on the screen-grid of

19

said tube during periods that said tube is not conducting current.

17. A structure as claimed in claim 10 in which said condenser is connected to an output circuit comprising an electronic amplifier, an isolating element between said amplifier and said condenser, and the amplifier having a path to ground to maintain said condenser at substantially ground potential when said charging circuit is at said low potential.

18. A structure as claimed in claim 17 in which said isolating element comprises a diode.

19. In combination with a registration control device operating to maintain registration of two operations performed on a moving web at stations spaced along the length of the web and in which there is a first signal producing device producing a first signal in synchronism with one operation, a second signal producing device producing a second signal in synchronism with said second operation, the signals each having a duration inversely proportional to the speed of said web and adapted to have a predetermined occurrence relationship for registration, having means for comparing said signals and producing an error signal output when said operations are not in synchronism and correction means for changing the length of web subtended between said operations in response to said error signal to bring said operations back into registration, means for electrically delaying one of the signals to simulate physical adjustment of the position of one of said signal producing devices along the length of said web to change the said occurrence relationship for any condition of registration, which comprises, a delay circuit interposed between one of said signal producing means and said comparing means and having a normally quiescent electrical storage element therein, a substantially linear charge circuit for said element operated by the beginning of the signal from said one signal producing means and a normally inoperative substantially linear discharge circuit operated by the end of the said signal from said one signal producing means, whereby the duration of the output signal from said delay circuit is varied for a fixed length of web in accordance with the speed of said web, and means for changing the duration of said discharge to create an error signal for bringing said operations into registration.

20. The combination as claimed in claim 19 in which said last mentioned means comprises a manually variable circuit element in said charging circuit operable to change the rate of charge of said storage element.

21. The combination as claimed in claim 19 in which said last mentioned means comprises a manually variable circuit element in said discharge circuit operable to change the rate of discharge of said storage element.

22. A structure as claimed in claim 20 in which said one of said signal producing means is constructed to provide a substantially square wave output signal, and said storage element is a condenser, the charge and discharge circuits of said condenser being substantially independent and the charge and discharge characteristics forming the legs of a triangle, said circuit element comprising a resistor and the variation thereof serving to vary the slope of the leg of said triangle comprising said charge characteristic, without varying the slope of the other leg.

23. In an operation control device in which an object moves relative to an operation performing station at which an operation is to be performed upon said object at a certain time related to the speed at which said object reaches said station, a correction means is provided for changing said speed to the proper rate, means are provided for producing first and second signals separated by a time related to said speed, and means are provided for driving said correction means in response to the relationship between the occurrence of said second signal and the time of said operation; means for changing the last-mentioned relationship which comprises, a charge-discharge circuit between said signal producing means and said correction

20

means for effectively delaying the occurrence of said second signal and having substantially linear charge and discharge characteristics, the charge portion of said circuit being initiated by said first signal and the discharge portion being initiated by said second signal, and means for manually varying the rate of one of said portions to vary the total time for charge and discharge to derive a signal having a desired relationship to the time of said operation for driving said correction means accordingly.

24. In a registration control device in which a web moves relative to a pair of spaced operation performing stations and a signal produced at said first operation performing station is adapted to be compared with a second signal produced at a second operation performing station to make correction in the synchronism of operations performed; signal producing means at said first station producing said first signal with a duration which is inversely proportional to the web speed, means for delaying said signal prior to comparison with said second signal and comprising, a charge-discharge circuit having a linear characteristic, the charge starting at the beginning of the first signal and the discharge starting at the end of said first signal, said discharge comprising the delay and being inversely proportional to the speed of said web to permit a comparison between said discharge and the second signal produced at said second operation for introducing a correction in the synchronism of operations dependent on the speed of the web.

25. In a web detecting system wherein a plurality of successive signals are derived each corresponding to a respective spaced apart moving position on a web and having a time duration therebetween related to the speed at which the spaced apart positions are moving and in which means are provided for deriving a scanner signal corresponding to a predetermined position on said web, the improvement comprising means operated at a predetermined rate from a normal position responsive to the appearance of the first of said plurality of signals, means for returning said operated means to normal at a certain rate responsive to the appearance of a second of said plurality of signals whereby the time period in which said operated means returns to normal is dependent upon the speed at which said spaced apart positions are moving, and means controlled on return of said operated means to normal for providing a last signal related to the time interval between said first and second signals and therefore the speed at which said spaced apart positions are moving to permit a comparison between said scanner signal and said last signal to be established on the basis of the speed of said certain positions.

26. In the arrangement claimed in claim 25, means manually operated to a plurality of different positions for varying one of said rates to simulate a change in the distance between said spaced apart positions, whereby the position of said last signal with respect to said scanner signal is varied for respective positions of said manually operated means irrespective of said speed.

27. In a speed detecting circuit for deriving a signal related to the speed of an object and having a pair of signal derivation elements located a fixed distance apart for deriving respective signals on successive detection of said object movingly relative thereto, the improvement comprising a gate circuit operated responsive to a signal produced by one of said elements, charge-discharge means operated linearly at a predetermined charging rate and whose operation is commenced by said gate circuit whereby the degree of operation is controlled in accordance with the length of time same is operated, and means operated responsive to a signal produced by the second of said elements for resetting said charge-discharge means at a particular discharge rate whereby the time period in which said charge-discharge means is reset is dependent upon its degree of operation.

(References on following page)

21

References Cited in the file of this patent

UNITED STATES PATENTS

2,374,779	Preston	May 1, 1945	2,602,151
2,389,458	Preston	Nov. 20, 1945	2,695,955
2,412,542	Smith	Dec. 10, 1946	2,794,979
2,429,500	Wolfner	Oct. 21, 1947	2,806,651
2,516,454	Doran	July 25, 1950	2,840,371
2,522,957	Miller	Sept. 19, 1950	2,840,372
2,529,161	Kelling et al.	Nov. 7, 1950	2,853,609
			2,871,350
			2,877,416

22

Carbrey	July 1, 1952
Casey	Nov. 30, 1954
Palmer	June 4, 1957
Fernsler	Sept. 17, 1957
Frommer	June 24, 1958
Alhand	June 24, 1958
Ropiequet et al.	Sept. 23, 1958
Casey	Jan. 27, 1959
Grisdale	Mar. 10, 1959