

Oct. 30, 1956

C. M. NOBLE

2,768,827

REGISTRATION CONTROL DEVICE

Filed June 7, 1952

4 Sheets-Sheet 1

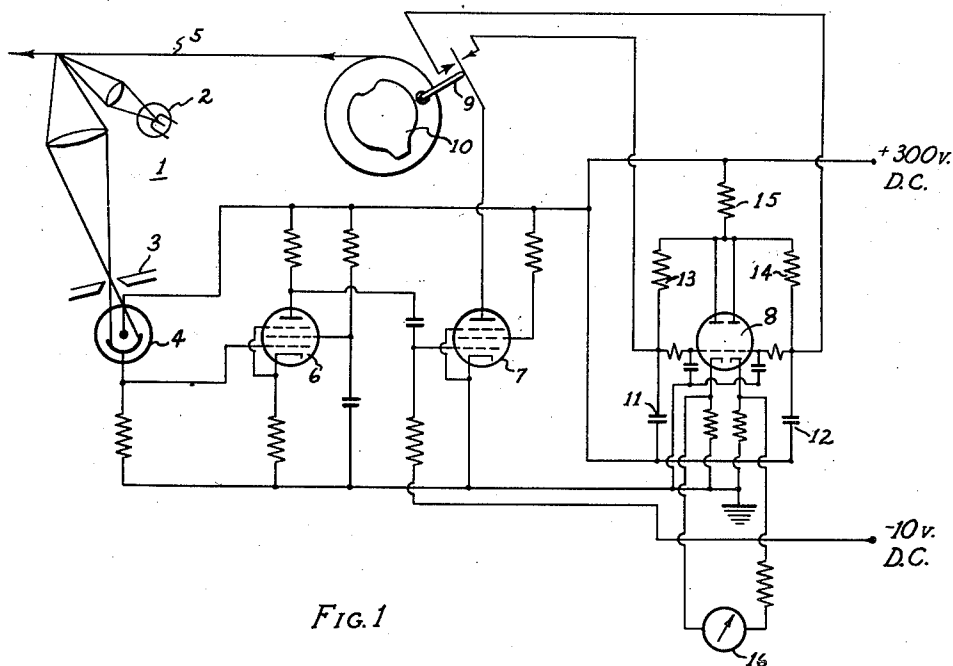


FIG. 1

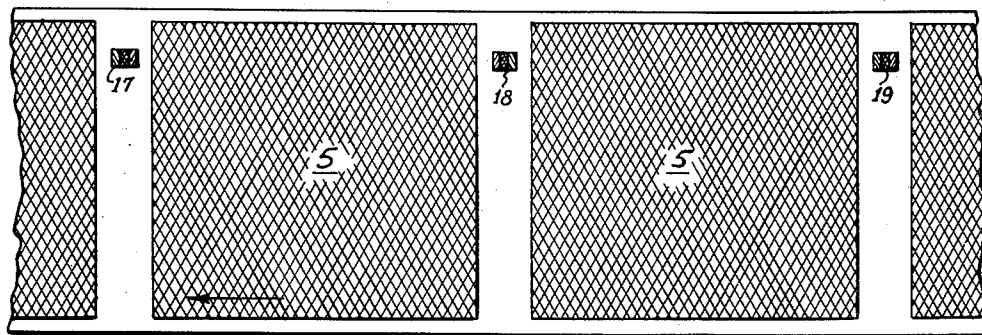


FIG. 2

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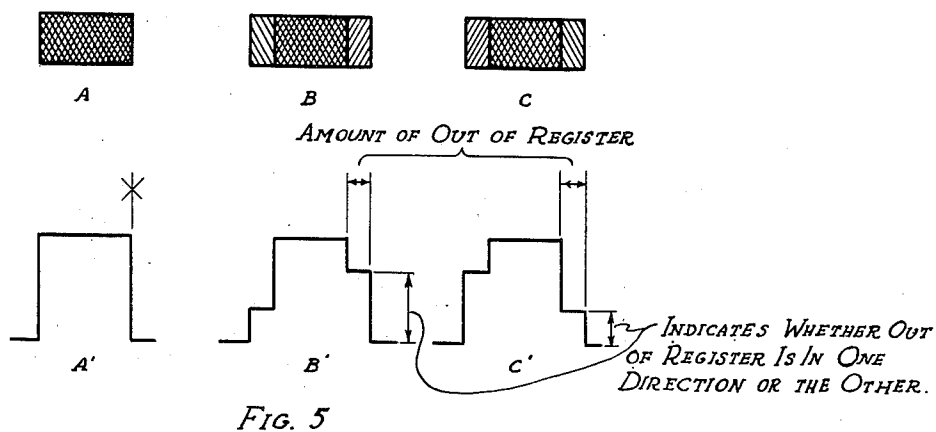
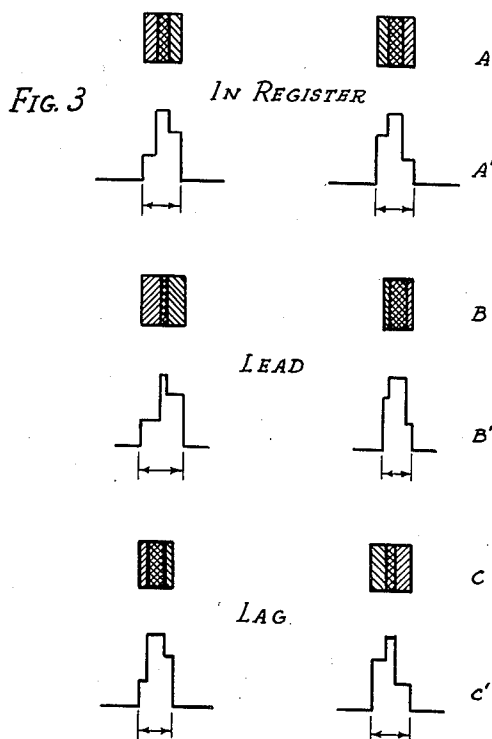
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4 Sheets-Sheet 3

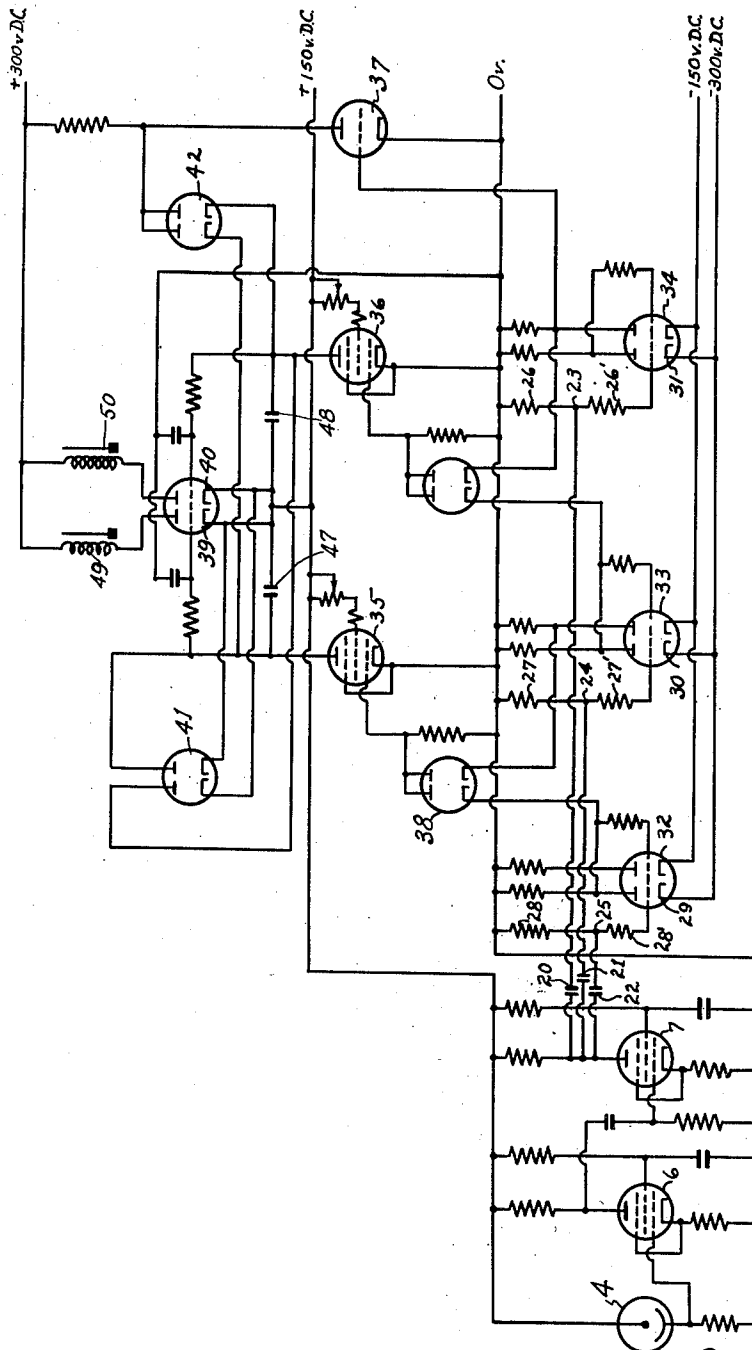


FIG. 4

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4 Sheets-Sheet 4

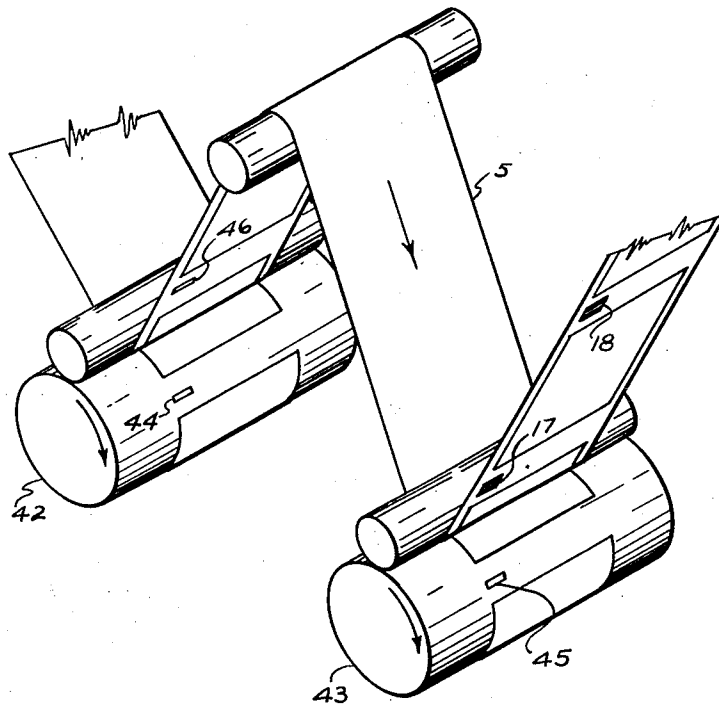


FIG. 6

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REGISTRATION CONTROL DEVICE

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2 Claims. (Cl. 271—2.6)

This invention relates to an improved registration control device in which the overlapping of indicia is used as the control means.

Present methods for indicating or correcting the register of the movement of the web in rotary multicolor printing presses uses one of the following two principles:

(1) The time at which a photoelectric signal originating from a mark printed by a first cylinder occurs is compared with the time at which a second signal occurs. The second signal is originated by the arrival of a second color print cylinder in a certain position.

(2) The time at which a photoelectric signal originating from a mark printed by a first cylinder occurs is compared to the time at which a photoelectric signal originating from a mark printed by a second cylinder occurs. ("First" refers to any earlier cylinder, "second" to any later cylinder.)

The first mentioned principle has been used extensively, but it has the disadvantage that it requires the very exact coupling of a means for originating a signal to at least one cylinder. These means of coupling, if they are accurate enough to give information on deviations of the order of one thousandth of an inch, are both bulky and delicate. They considerably detract from the space available around a press and increase its vulnerability. Furthermore, each time a cylinder is removed from the press for the purpose of inserting a new one, the position of the printing on the new cylinder with respect to said means of originating the signal indicative of the position of the cylinder has to be reestablished.

The second principle was suggested many years ago, and requires two photoelectric pickups or "scanners" for each stage of measurement or correction, one pickup to be influenced by a mark printed by one cylinder and the other pickup to be influenced by a mark printed by another cylinder. This system requires provisions to prevent one mark from influencing the photoelectric pickup intended only to be influenced by the other mark. The simplest way of obtaining this is to print the two marks in two separate tracks, but such practice interferes with optimum utilization of the paper available for the printing proper. For these reasons and maybe for other similar reasons, this second principle has never been employed practically to any considerable extent.

It will be noted that present practice relies on finding the coincidence (or lack of coincidence) of two signals by picking up each signal, amplifying them separately and comparing the time of arrival of these two signs.

This procedure has the disadvantage that in addition to requiring two amplifiers, the errors occurring in each of these amplifiers may be cumulative.

According to the present invention, indicia are placed at least partly over each other by two different cylinders and they are picked up by one single photoelectric amplifier, and this single amplifier gives information on whether the printing of one cylinder is ahead or behind the printing of the other cylinder.

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To do this, advantage is taken of one or more of the following facts:

Some combinations, as e. g. yellow and red may give photoelectric signals which are substantially different for one color for the other color and for the simultaneous presence of both colors without any special provision. If the contrast is not sufficient, then it can be emphasized by color filters in front of the phototube, or by printing at least one of the colors in "half tone" or in reduced width.

(1) The two indicia to be compared, applied for example in different colors, may be made to cause photoelectric signals of substantially different intensities in the scanner and the portions on which both are applied one over the other will give a photoelectric signal of higher intensity than the signal from either of the indicia applied alone.

(2) By printing two marks so that one color overlaps on one end and the other color overlaps on the other end in the direction of web travel, an off register condition in one direction will increase the duration of the overall signal, and an off register condition in the other direction will shorten the duration of the overall signal. (By overall signal, we mean the photoelectric signal originating from a mark of either color or both colors simultaneously.) The same results can be obtained by placing any other indicia on the web such as openings, cuts, etc.

(3) Coarse register (within say $\frac{1}{8}$ ") can easily be indicated by simple mechanical timing devices which can be placed at any distance from the printing cylinder and driven through gears and shafts even though they have so much backlash and distortions that they would spoil indications accurate to the order of one thousandth of an inch.

My invention can be best understood by referring to the drawings in which one embodiment covering points 2 and 3 above is illustrated by Figures 1, 2 and 3 in which Figure 1 is a schematic drawing of the optical system and the circuit connected therewith, Figure 2 illustrates the relationship between the indicia marks and the printing placed on the web and Figure 3 (A, A'; B, B'; and C, C'; showing in register, lead and lag respectively) illustrates the effect of the marks on the shape and strength of the signals. A second embodiment illustrating point 1 above is shown in Figures 4 and 5 in which Figure 4 illustrates the photoelectric and amplifying circuit and Figure 5 (A, A'; B, B'; and C, C'; representing respectively in register, lead and lag respectively) shows the relationship between the signal received and the mark. Figure 6 illustrates one means of placing indicia on the web in an overlapping manner.

It should be understood that while the above embodiments will be discussed herein in connection with colored marks as the indicia, other indicia such as slits, raised marks, opening, notches, etc. can be used within the scope of my invention.

In general, one embodiment of my invention, as illustrated by Figures 1, 2 and 3, operates as follows:

Each cylinder prints two marks, which may be, for example, approximately 180° apart around the print cylinder and in the same lateral position on the cylinder. Each of these marks, 17, 18 and 19, is, say $\frac{1}{8}$ " wide (in direction of web travel) and say $\frac{1}{2}$ " long (in lateral direction). The cylinders are so engraved that when the two cylinders print in perfect register, the first mark printed by the first cylinder leads exactly $\frac{1}{16}$ " before the first mark printed by the second cylinder and the second mark printed by the first cylinder lags exactly $\frac{1}{16}$ " after the second mark printed by the second cylinder as illustrated in Figure 3A. A scanner is provided near the path of the web. When the marks arrive under this scanner 1,

they are illuminated by lamp 2 and imaged (say in full size) on a mask 3 measuring, say, $\frac{3}{8}$ " laterally and $\frac{1}{64}$ " in direction of web travel. A photo tube 4 is behind the mask. Accordingly, as the printed web 5 passes in front of this single scanner it will see first for $\frac{1}{16}$ " of web travel the first color, then for $\frac{1}{16}$ " of web travel both colors, and finally for $\frac{1}{16}$ ", the second color. After approximately a half revolution of the print cylinders, it will see for $\frac{1}{16}$ " the second color, then for $\frac{1}{16}$ " both colors, and finally for $\frac{1}{16}$ " the first color. Thus the photo tube 4 will send a signal for $\frac{1}{16}$ " of web travel in both cases. The time curve of the photoelectric signal is shown schematically in Figure 3A¹. If the printing of these two cylinders gets out of register, so that the second color comes later than it should, then the length of the overall signals which was $\frac{3}{16}$ " for both marks will change. The overall length of the first signal, in which the second color comes last, will increase; and the overall length of the second signal, in which the second color comes first, will decrease. See Figures 3B and 3B¹. For off register in the other direction see Figures 3C and 3C¹. The photoelectric signal is amplified by tubes 6 and 7 until it is sufficient to cause a triode 8, which is normally in cut off (i. e. delivers no plate current whatsoever) to deliver a "saturation" current independent from the magnitude of the originating photoelectric signal (i. e. whether the signal came from the first color, the second color, or from both colors one over the other). A double throw switch 9 is actuated by a cam 10 on the print cylinder. It is so timed that one side closes say $\frac{1}{16}$ " before the arrival of the first signal and opens $\frac{1}{16}$ " after the departure of the first signal. The other side of the switch closes $\frac{1}{16}$ " before the arrival of the second signal and opens $\frac{1}{16}$ " after the departure of the second signal.

One side of the switch switches the plate of the aforesaid pentode 7 into a first condenser 11 and the other side of the switch switches the current of this pentode into a second condenser 12. The two condensers are bled by two identical resistors 13 and 14 toward a point held at say plus 300 volts through a third resistor 15. As long as the two signals are of equal duration, the two condensers 11 and 12 receive identical charges, and the average voltage on each will be the same. If, however, the duration of one signal decreases and the duration of the other signal increases, then the charge on one condenser decreases and the charge on the other condenser increases. This causes an unbalance which can be indicated on an instrument connected across the cathodes of a cathode follower twin triode, the grids of which are connected to the two condensers. To insure a substantially unchanged voltage on the two condensers despite using cylinders of different circumference with marks of identical length the two resistors bleeding the condensers are connected to the third resistor 15 which in turn carries the plate current of the cathode follower triodes. Accordingly, whenever a change in cylinder circumference would cause the charge of the condensers to drive the cathode followers out of their proper range, degeneration restores the proper conditions.

Relays can be operated when the meter indicator 16 exceeds some predetermined position e. g. by a contact-making meter. This system requires no clear space whatsoever above the size of the overall signal increased by say $\frac{1}{8}$ " each side, before and after, the marks. If on the other hand, in addition to the fine control, a coarse control is desired, this can be furnished by comparing the time at which the switch closes against the arrival of the respective photoelectric signals, and such coarse register can be extended to any length which is being held clear before and after the printed marks. This coarse indication or control (which for reasons stated previously would not be exact) can be done in existing ways well known in the art.

Figure 3 also shows that the amplifier registers only by

the duration of one signal relative to the other irrespective of the signal strength.

Figures 4 and 5 illustrate a second embodiment of my invention and operate in the following manner:

In this case I use a clear track and no switching, although a similar system could be used without clear track providing switching devices are being used. I make use of the fact that different colors give photoelectric signals of substantially different amplitude. I require that two identical marks be printed, one exactly over the other for perfect register as per Figure 5A. When the light color comes too early, the mark resembles Figure 5B, and when the light color comes late, the mark resembles Figure 5C. The scanner is similar to scanner 1 of Figure 1. The amplified photoelectric signal (phototube 4, tubes 6 and 7) is brought through three condensers 20, 21 and 22 to three junctions 23, 24 and 25 respectively of pairs of resistors 26, 26¹; 27, 27¹; and 28, 28¹ respectively, so chosen that a signal substantially below the level of a signal corresponding to the lighter color will leave all three tubes 29, 30 and 31 (see Figure 4) in saturation. A signal corresponding to the lighter color will cause tube 29 to cut off. A signal corresponding to the darker color will cause tubes 29 and 30 to cut off, and a signal corresponding to simultaneous presence of both colors will cause all three tubes 29, 30 and 31 to cut off. The plate of each tube 29, 30 and 31 is connected to the grid of one of three tubes 32, 33 and 34 respectively, which have their cathodes at a higher potential than the potential of cathodes of tubes 29, 30 and 31. When one of tubes 29, 30 and 31 is in saturation, the corresponding tube 32, 33 or 34 respectively will be in cut off. Whenever one of these tubes 29, 30 or 31 is in cut-off, the corresponding tube 32, 33 or 34 is in saturation. Tubes 29, 30, 31, 32, 33 and 34 are connected with control tubes 35, 36 and 37, the grid of tube 35 is connected to the plates of tubes 29 and 33 through a diode 38 which causes this grid to assume the more negative of these two potentials. Therefore tube 35 can pass current only when tube 29 is in saturation and tube 30 is in cut-off. In a similar manner, I control tube 36 so it passes current only when tube 30 is in saturation and tube 31 is in cut-off. Thus tube 35 carries current for the duration of a signal corresponding to the lighter color, and tube 36 carries current for duration of a signal corresponding to the darker color. When tube 35 carries current the condenser 47 which is connected from the plate of tube 35 to the plate supply of tube 35 assumes a charge which is proportional to the length of time tube 35 is conducting. Similarly the other condenser 48 will assume a voltage depending on the length of time during which the tube 36 was conducting. If the charge on condenser 47 is sufficient it lowers the potential on the grid of tube 39 and causes it to reduce plate current and allows the relay 49 in its plate circuit to open to indicate or correct off register in one direction. Similarly when tube 36 conducts for a sufficient length of time tube 40 will open the relay 50 in its plate circuit to indicate or correct off register in the other direction. Now as the portion printed by both colors appears tube 31 goes into cut-off, tube 34 into saturation and tube 37 to cut-off. This allows the potential appearing on the plates of twin diode 42 to rise to a point sufficient to allow it to conduct and discharge the condensers 47 and 48 which were charged by tubes 35 and 36 to the potential of the cathodes of tubes 39 and 40. Twin diode 41 prevents further raise.

The charge which will be given to one or the other of the condensers 47 and 48 by tube 35 or 36 by the portion of the mark immediately preceding the simultaneous appearance of both colors will be of such short duration that the corresponding tube 39 or 40 will not have time to follow, due to the length of the time constant in the filters in the grid circuits of tubes 39 and 40. The charge which will be given to one or the other

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condenser 47 or 48 by tube 35 or 36 by the portion of the mark immediately following the simultaneous appearance of both colors will remain on the condenser for the length of time of one cylinder revolution, until both colors appear simultaneously again, which is sufficient length of time to allow tube 39 or 40 to act. It should be noted that it is only the portion of the mark immediately following the simultaneous appearance of both colors that will be effective to indicate or correct misregistry. The variable resistors in the screen circuits of tubes 35 and 36 will allow control of the amount of current tubes 35 and 36 will conduct and thereby control the amplitude of the charge they place on the condensers. This allows control of the amount of off register which can be tolerated without causing the relays to operate.

Referring to Figure 6, which illustrates one means of placing indicia on the web, printing cylinder 42 having etched mark 44 places printed mark 46 on the web 5. Similarly, etched mark 45 on printing cylinder 43 overlaps mark 46 to obtain the composite mark 17. In a similar manner marks 18 and 19 as shown in Figure 2 are also produced.

A similar circuit can also be used within the scope of my invention to indicate the off-register, or to cause more or less correction according to whether the colors are more or less off register.

I claim:

1. In a registration control device having means for detecting deviations in register between the operation of a second operating element and a first operating element on a moving web the improvement comprising means for placing two first indicia on the web at the position of operation of said first operating element, means placing two second indicia on the web in the position of operation of said second operating element in such a relative position that one of said second indicia is partly superimposed over one of said first indicia and the other of said second indicia is partly superimposed over the other of said first indicia in the direction of travel of said web in such a way that one combined indicium is lengthened and the other combined indicium is shortened when said second operating element is leading with respect to said first operating element while

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the first named combined indicium is shortened and the second named combined indicium is lengthened when the second operating element is lagging with respect to the first operating element, means detecting the time duration of the passage of the first of said combined indicium in front of a sensing device and means comparing said time duration with the time duration of the passage of the second of said combined indicium including means indicating the amount and direction of misregister.

2. In a device for obtaining an electrical signal indicative of the deviations in register between the operation of a second operating element and a first operating element on a web the improvement comprising means placing two first indicia on said web in the position of operation of said first operating element, means placing two second indicia on said web in the position of operation of said second operating element, in such a relative position that one of said second indicia is partly superimposed over one of said first indicia and the other of said second indicia is partly superimposed over the other of said first indicia in the direction of travel of said web such that one combined indicium is lengthened and the other combined indicium is shortened if said second operating element is leading with respect to said first operating element, sensing means responsive to the occurrence of the combined indicia on said web causing an electric current to charge a capacitor for the duration of the passage of said first combined indicium in front of it and causing a similar current to charge a similar capacitor for the duration of the passage of said second combined indicium in front of it and means generating an electrical signal as a function of the difference of the charges thus imparted to said capacitors.

References Cited in the file of this patent

UNITED STATES PATENTS

1,418,481	Sherman	June 6, 1922
2,002,814	Harrold	Jan. 14, 1932
2,220,736	Stockbarger	Nov. 5, 1940

FOREIGN PATENTS

450,528	Great Britain	Apr. 17, 1935
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