

Sept. 12, 1950

C. S. CRAFTS

2,522,479

REGISTRATION CONTROL DEVICE

Filed Sept. 27, 1946

3 Sheets-Sheet 1

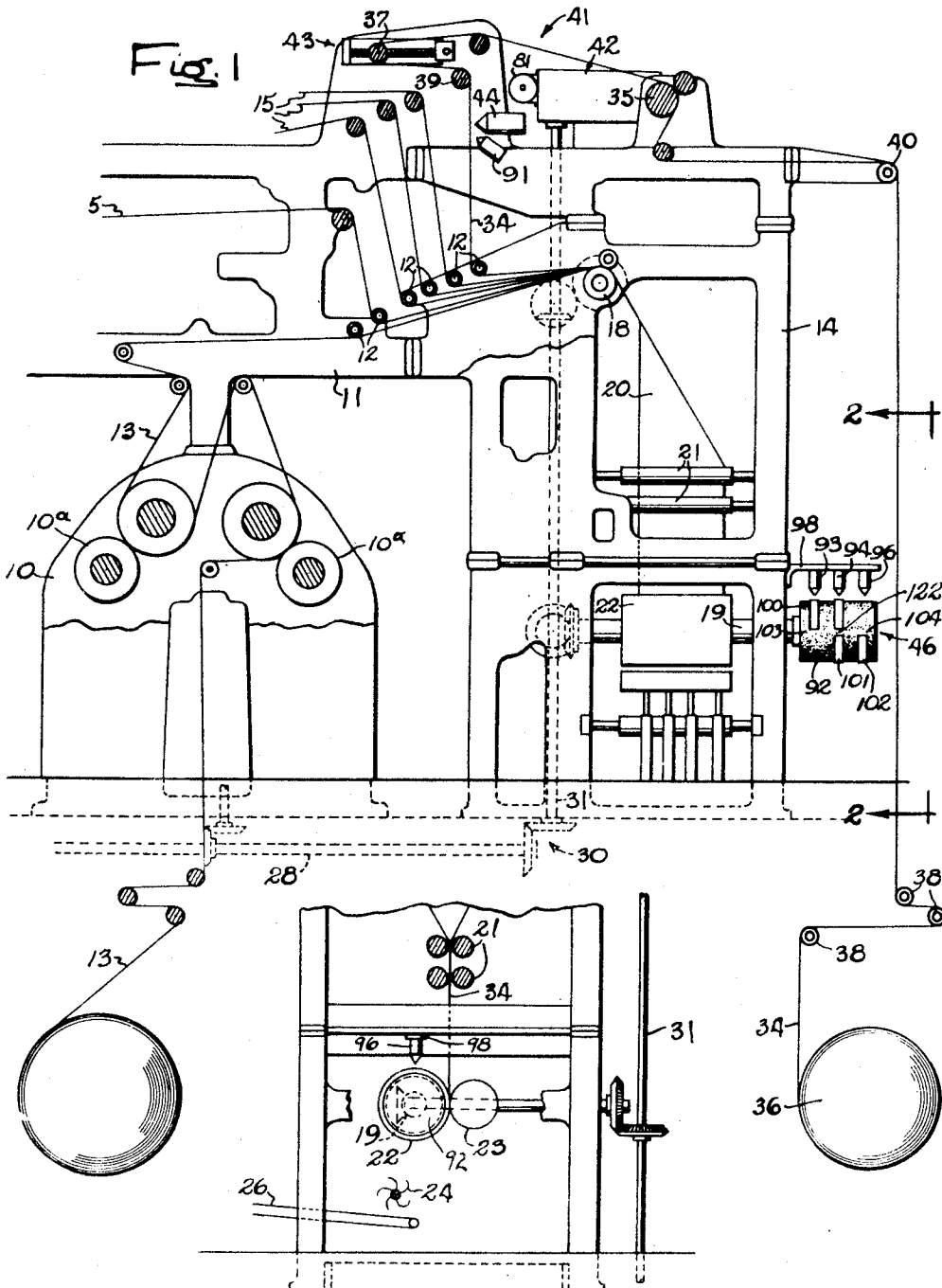


Fig. 2

INVENTOR
Curtis S. Crafts
Carlson Pitzner Hubbard & Wolfe
ATTORNEYS

Sept. 12, 1950

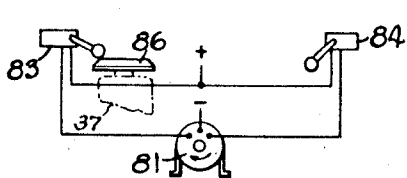
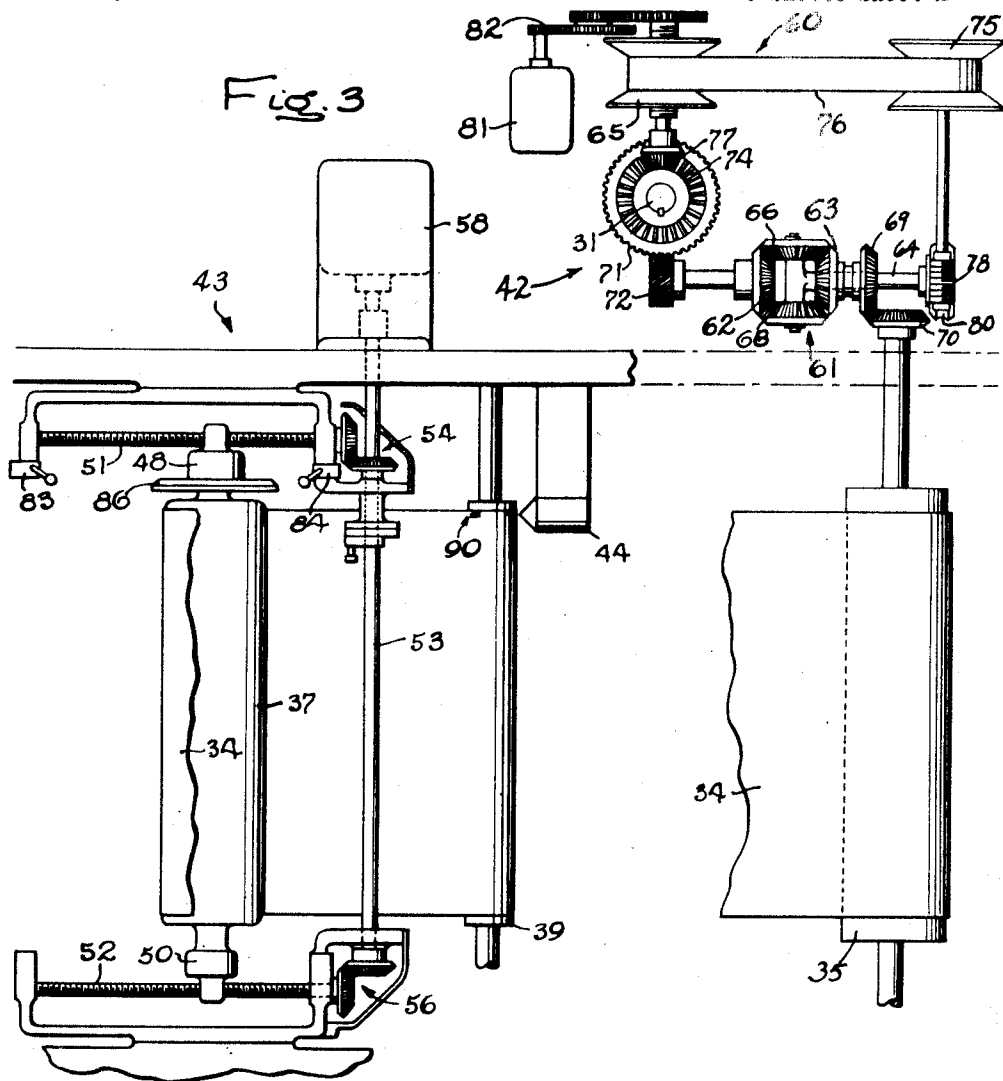
C. S. CRAFTS

2,522,479

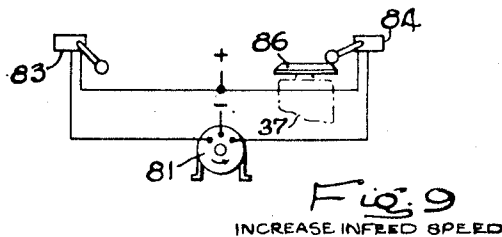
REGISTRATION CONTROL DEVICE

Filed Sept. 27, 1946

3 Sheets-Sheet 2



DECREASE INFED SPEED



INCREASE INFED SPEED

INVENTOR

Curtis S. Crafts

Carlson Pitzer Hubbard & Wolfe

ATTORNEYS

Sept. 12, 1950

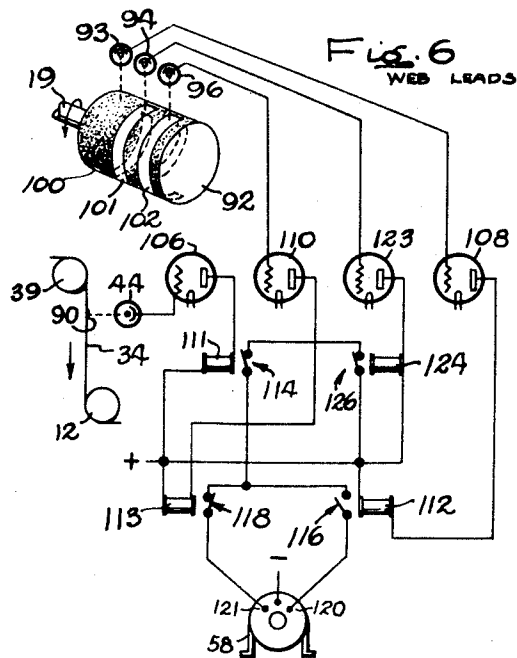
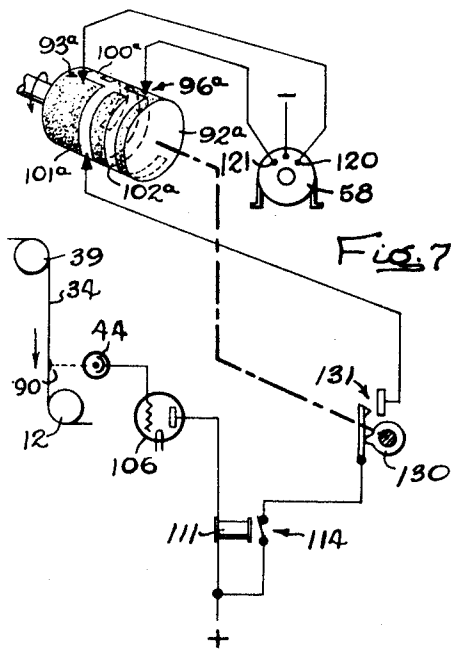
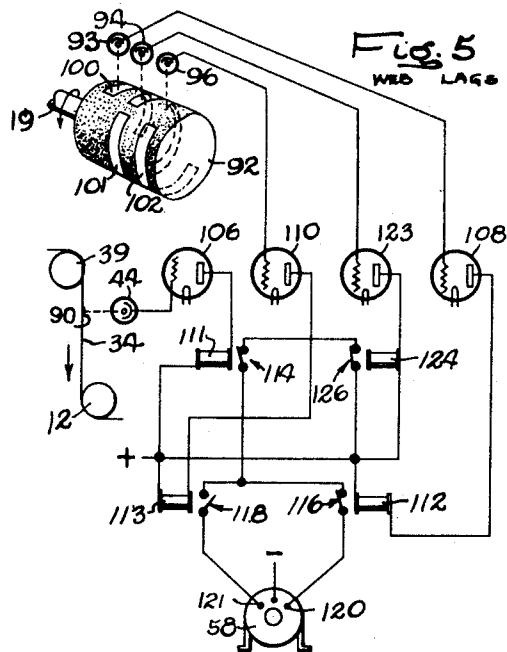
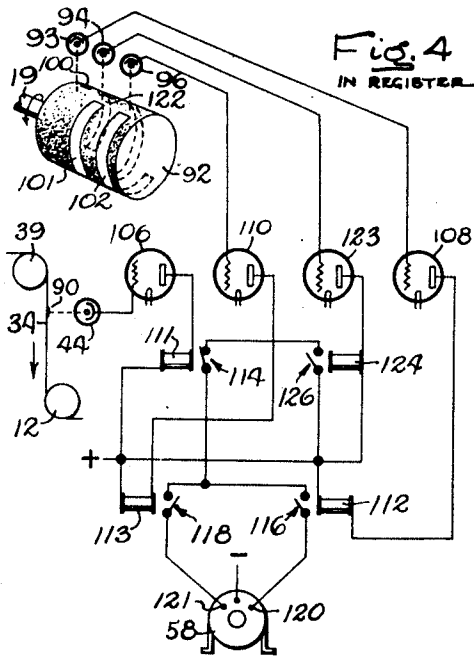
C. S. CRAFTS

2,522,479

REGISTRATION CONTROL DEVICE

Filed Sept. 27, 1946

3 Sheets-Sheet 3



INVENTOR
Curtis S. Crafts
Carlson Pitner Hubbard & Hall
ATTORNEYS

UNITED STATES PATENT OFFICE

2,522,479

REGISTRATION CONTROL DEVICE

Curtis S. Crafts, Oak Park, Ill., assignor to The
Goss Printing Press Company, Chicago, Ill., a
corporation of Illinois

Application September 27, 1946, Serial No. 699,897

12 Claims. (Cl. 270—52)

1

The present invention relates to registration control devices for web fed printing presses. More particularly the invention relates to means for producing registered insertion of a pre-printed re-rolled web.

A primary object of the present invention is to provide in a printing press an improved registering control for combining two or more webs in which difficulties caused by short printing or cumulative error are positively overcome and in which accurate registration may be accomplished at even the highest letter press speeds.

Another object of the invention is to provide a registration control including an adjustable compensator roller and web speed control in which the speed control is adjusted as an incident to approaching the limit of adjustment of the compensator roller.

It is a further object of the invention to provide an improved registration control for associating a pre-printed web with a main web in which a large amount of misregistration, caused, for example, by splicing either of the webs may be readily corrected with a minimum number of wasted copies, and in which danger of over-travel and jamming of the registration control normally associated with large amounts of registry correction is completely eliminated.

A still further object of the invention is to provide a registration control device for use in the insertion of a pre-printed web which may be quickly and easily adapted for use with a standard letter press and which, although having important operating advantages over prior art devices, is simple and straightforward in construction and, lending itself to the use of standard electrical and mechanical components, is considerably less expensive to produce.

In one of its aspects an object of the invention is to produce a control for the registration of an inserted web and a main web in which registration data is obtained from the inserted web and from means rotating in unison with the main web completely through the use of photoelectric cells and without the necessity of using sliding electrical contacts.

Further objects and advantages of the invention will become apparent as the following description proceeds, taken in connection with the accompanying drawings in which:

Figure 1 is a view in elevation of means for accomplishing registered insertion of a pre-printed web in accordance with my invention as applied to a newspaper press of conventional construction.

2

Fig. 2 is a fragmentary view in elevation showing the appearance of the press illustrated in Fig. 1 as seen from the right-hand end thereof.

Fig. 3 is a fragmentary plan view of the press illustrated in Fig. 1 showing the compensating roller and in-feed driving roller together with means for accomplishing the adjustment of each.

Fig. 4 is a simplified schematic diagram of the registration control circuit showing the position of the control relays during an assumed condition of registration equilibrium.

Fig. 5 shows the circuit illustrated in Fig. 4 with the control relays in positions corresponding to a lagging web.

Fig. 6 shows the circuit illustrated in Fig. 4 with the control relays in positions corresponding to a leading web.

Fig. 7 illustrates an alternative registration control circuit in which a commutator and associated sliding electrical contacts are used in lieu of photoelectric cells to detect lack of registry.

Figs. 8 and 9 are electrical diagrams showing the manner in which the in-feed speed is controlled.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

In conventional types of rotary printing presses it is customary to feed a number of webs of paper through the machine simultaneously and to bring them together in registry before the final association, folding, and cutting process. Such webs are operated upon simultaneously throughout the process from the time they are introduced as plain paper into one end of the machine until they pass out in the form of complete newspapers at the other end. Local adjustment to secure registry during the passage of any of these webs through the machine is commonly hand operated. Since all of the plate cylinders are driven by a common or synchronized driving means, there is little or no tendency for the webs to get out of register once they have been adjusted.

In present day newspaper practice, however, it is often desirable to insert a pre-printed web prior to association, folding, and cutting of the webs; for example, it may be desirable to pre-

print a web of four-color work in a rotogravure unit and to store it in re-rolled form for later insertion. There are numerous difficulties involved in the insertion of a pre-printed web. In the first place, as a practical matter it is not possible to cause the impressions on a rotogravure web to be spaced at exactly the same distance apart as the impressions on the main web with which it is to be associated. For example, if the rotogravure cylinders differed from a predetermined diameter by only one thousandth of an inch, the error in registration of the printed matter on the web, being rapidly cumulative, would amount to a total of several inches for one thousand sheets. Moreover, shrinkage and expansion due to atmospheric conditions and stretching of the web from mechanical causes all contribute to improper registration.

In an attempt to overcome the above difficulties some presses have been operated with the rotogravure unit lined up with the letter press unit and the webs printed simultaneously. This scheme is of extremely limited application, however, primary because of the greatly reduced speed at which the unit as a whole must be driven. This results from the fact that four-color presses have generally not been operated at a rate in excess of 36,000 papers per hour, whereas letter press printing is frequently done at 48,000 to 50,000 papers per hour. Furthermore, this arrangement practically doubles the size of the press required in addition to requiring a large number of extra pressmen having different skills. Then, too, the fumes from the special ink used in the rotogravure process are objectionable. In the event of accident much more time is required to produce a replacement rotogravure cylinder so that shutdowns are likely to be longer and more costly. The problem therefore resolves itself to providing means for keeping a pre-printed web in registration with a main or cooperating web in spite of the above-mentioned causes tending to produce misregistration.

Early attempts to solve the problem, involving the use of punched holes at spaced intervals along the margin of the pre-printed web and the use of a tension control operated by contacts actuated through the marginal holes, failed because of the cumulative errors in the positioning of the colored impression on the pre-printed web. Subsequently, a so-called "intersetter" control was developed and may be found described in British Patent No. 316,956, dated August 1, 1929. In this device misregistration results in a simultaneous repositioning of the register bar or roller and a change in the speed of an in-feed roller. Although this scheme suffers to a lesser extent from the difficulties arising because of cumulative error, only limited amounts of such error can be tolerated. In both of the above appreciable cumulative error results in the running of the register bar to one or the other of its extreme positions requiring a shutting down of the press until the registration control mechanism can be completely readjusted. In addition, the electrical and mechanical components are inherently complicated and the devices, for the most part, must be completely custom-built, increasing the difficulties of maintenance and repair.

Contrasted with the above the device herein described is such that webs having large amounts of cumulative error may be combined with no difficulty whatsoever, completely avoiding the necessity of shutting down the press upon reach-

ing the limit of adjustment of the compensator bar. This is caused to a great extent by the fact that the present control system does not depend for its success on the maintenance of a static positional equilibrium, but instead utilizes a state of "dynamic" equilibrium. By the latter term it is meant that the registration adjusting elements are normally in motion, constantly seeking out the position of accurate registration. As will later be seen, such constant adjusting movement can be caused to take place rather rapidly or extremely slowly as may be desired for a particular installation. Furthermore, the applicant's device is such as to quickly and automatically correct for large initial errors of registration which may be caused, for example, by splicing the web.

Referring more particularly to the drawings, Fig. 1 shows the end portion of a multiple unit newspaper press including a final perfecting type press unit 10 having plate cylinders 10a. The press unit 10 is joined to a conventional overhead frame 11 carrying rollers 12 for guiding the web 13 from the press unit 10 together with the webs 15 printed on press units (not illustrated) to the left of the one shown.

At the right of the frame 11 is a frame 14 of the conventional type of folder unit for folding and cutting the associated webs and into which the webs are drawn by means of a main draw roller 18. After passing from the latter the combined webs are folded on a former 20 and then fed through nipping rollers 21 and between cylinders 22 and 23. Conventionally, cylinder 23 carries a knife blade for cutting the folded webs into separate newspapers and a tucker blade to give the newspapers a second fold. Cylinder 22 mounted on shaft 19 receives the cutting edge, and the jaws built into cylinder 22 pass the severed and folded papers to a delivery fly 24 and a delivery belt 26.

Power is supplied to the printing, folding, cutting and delivery mechanisms by a main horizontal drive shaft 28 which extends longitudinally below the press frame. Through the medium of bevel gears 30 at the end of the shaft 28, power is transmitted to a vertical drive shaft 31 which in turn drives the folding and cutting cylinders 22, 23, the main draw roller 18 and, as will later appear, the in-feed mechanism for drawing a pre-printed web into the press. Since all of the presses and the rollers in the folding and cutting mechanism are geared to a common source of power, it is impossible under ordinary circumstances for them to get out of step. Consequently the angular position of the folding and cutting cylinder and its shaft 19 is an accurate indication of the positioning of the inked impression on the main webs, which fact, as will later be seen, is useful in maintaining registration of an inserted pre-printed web.

The foregoing structure, however, is merely illustrative of one type of newspaper or letter press with which my registration scheme may be used and forms no part of the present invention. As a matter of fact, the mechanism to be described is equally applicable to other types of presses, for example, a magazine press and for use with other types of forming and folding mechanisms.

In the present embodiment a pre-printed or inserted web indicated at 34 is supplied from a storage roll 36 and is associated with the main webs just prior to engaging the main draw roller 18 referred to. After leaving the storage roll

36 the pre-printed web is passed over auxiliary and tension regulating rollers 38, thence upwardly over roller 40 and into the compensating and speed controlling portion of my device mounted at the top of the press frame and indicated generally by a numeral 41. Here the web 34 is engaged first by a draw or in-feed roller 35, then passed over a compensating roller 37 and finally over an idler roller 39. The mechanical components for compensation and speed control are more completely shown in Fig. 3, the speed controlling assembly being designated generally as 42 and the compensator assembly by the numeral 43. In the present embodiment both of the latter are controlled jointly in a novel manner by a photoelectric cell 44 which scans the pre-printed web 34 and by a photoelectric scanning arrangement 46 driven by shaft 19 from the main press drive. Although in the present embodiment the photoelectric cell scans the edge of the pre-printed web 34, it will be apparent that such scanning may take place along the center of the web or along any other desired line of movement.

As a feature of primary importance my invention contemplates utilizing variations in positional phasing between indicia on the pre-printed web and indicia associated with the main press drive shaft as detected by the photocell devices 44, 46 and in utilizing such variations to control the positioning of a "takeup" type of compensator roller. The compensator roller in turn, upon reaching the limits of its adjustment, varies the speed of the in-feed mechanism in the proper direction to remove accumulated error. Since in my improved device the compensator correction and feed (i. e., speed) correction takes place serially rather than simultaneously as in the prior art devices discussed above, the two types of correction may be conveniently discussed under separate headings.

Compensator roller adjustment

The means for bodily moving the compensator roller are shown in detail in the left-hand portion of Fig. 3. Here it is seen that the web 34 is trained over the compensator roller 37, thence over an idler roller 39 just prior to association with the remaining webs 13, 15. The compensator roller is arranged for sidewise bodily adjustment by being mounted on internally threaded supports 48 and 50 which engage horizontal lead screws 51 and 52 respectively. The latter are rotated simultaneously from a common adjusting drive shaft 53 through pairs of bevel gears 54 and 56. The adjusting drive shaft 53 is, in turn, driven by means of a compensator adjusting motor 58. By causing the motor 58 to rotate in a predetermined direction it will be apparent that the length of the partial loop of the web 34 passing over the compensator roller 37 may be lengthened to compensate for the condition where the pre-printed web is leading, while causing rotation of the motor 58 in the opposite direction will shorten the loop as necessary to compensate for a lagging web. It will be apparent, however, that the correction brought about by the compensator roller is only temporary in nature and persistence of the tendency of the pre-printed web to lead or lag will soon cause the compensator roller to reach one extreme or the other of its range of adjustment. Although normally considered a disadvantage, this condition is usefully employed

in the in-feed roller speed control arrangement to be described in the following section.

In-feed roller speed adjustment

Referring now to the right-hand portion of Fig. 3, it will be seen that the in-feed roller 35 is driven from the vertical drive shaft 31 through the in-feed roller speed control assembly 42 which is infinitely variable. Although various types of infinitely variable drives may be used without departing from my invention, the exemplary embodiment includes an adjustable belt drive 60, commonly known as a P. I. V. drive, and a differential 61. The differential is of a conventional type having an input element consisting of a bevel gear 62, a speed changing element 64 and an output element consisting of a bevel gear 63. Freely rotatable on the speed changing element 64 are intermediate bevel gears 66 and 68, the latter turning about an axis which is at 90° to the axis of rotation of the element 64. A pair of bevel gears 69 and 70 connect the output element 63 of the differential to the in-feed roller 35.

Input power to the differential 61 is obtained from two sources. The first source includes a direct connection to the vertical drive shaft 31, the input bevel gear 62 of the differential being coupled to the shaft 31 by means of the meshed gears 71, 72. The speed changing element 64, on the other hand, is driven via the adjustable belt (P. I. V.) drive 60 which in turn is powered through a pair of bevel gears 74, 77 from the vertical drive shaft 31. The belt drive 60 includes an adjustable sheave 65 and a sheave 75, the latter being drivingly interconnected by a belt 76. The sheave 75 in turn drives a worm 78, a worm wheel 80, and the speed changing element 64.

As is well known in differential practice the speed of the output element 63 is equal to the speed of the input element 62 arithmetically modified by twice the speed of the speed changing element 64. Since the speed of the speed changing element 64 may be made relatively low, adjustment of the P. I. V. drive enables very fine control of the output speed to be achieved, on the order of a fraction of an R. P. M. In the present embodiment, adjustment is effected by varying the distance between the tapered sides of the adjustable sheave 65. The latter may be gradually separated or brought closer together by any desired sheave adjusting means which may include a P. I. V. adjusting motor 81 and associated gearing 82. The motor 81 is reversible and may be energized by means to be described to change the driving ratio and thus the output speed of the speed control assembly 42. The latter determines the in-feed speed of the pre-printed web 34.

Coupling between compensator and in-feed adjustment

In accordance with the invention, means are provided for energizing the P. I. V. adjusting motor 81 in response to the approach of the compensator roller to one or the other of its limit positions. In the present embodiment energization of the motor 81 is controlled by limit switches 83 and 84 respectively which are operated by a limit switch cam 86 mounted to move bodily with the compensator roller support 48. The general nature of the circuit associating the limit switches 83, 84 with the P. I. V. adjusting motor 81 is shown in Figs. 8 and 9, one

or the other of the switches being operated upon approach of the compensator roller to its limiting positions.

Fig. 8 shows the condition existing when the web 34 is being drawn into the press at a rate which causes it to lead the webs 13, 15 being printed by the press. Under such circumstances the compensator roller 37 will be caused, by means to be later detailed, to take up such lead by increasing the length of the partial loop of web 34 which occurs upon movement of the roller 37 (Fig. 3) to the left. Such movement generally takes place in small steps until the limit of adjustment in this direction is reached. Thereupon the limit switch cam 86 will engage the limit switch 83 closing it and causing the P. I. V. adjusting motor to rotate in the "decrease speed" direction. The resultant decrease of speed brought about in the P. I. V. drive 60 will reduce the speed in the web in-feed roller 35, thereby counteracting any tendency for the pre-printed web to lead the main web. The latter protects the compensator roller adjusting mechanism from jamming and possible damage.

More importantly, since the P. I. V. adjusting motor 81 will continue to turn in a "decrease speed" direction as long as the switch 83 is closed, the speed reduction will continue until the web 34 is slowed to a point where it has a tendency to lag slightly. This tendency, detected by the photocell devices 44, 46, (to be detailed) will cause the compensator roller 37 to move to the right, in other words in a direction to shorten the partial loop of webbing which is passed around the latter, and thereby to compensate for the lagging web speed.

The first noted effect of movement of the compensator roller to the right is the opening of the limit switch 83 and the deenergization of the P. I. V. adjusting motor 81. The in-feed roller 35, however, will continue to turn at a rate which is slightly lagging, and such tendency toward lagging will continue to be overcome by movement of the compensator roller 37 toward the right. Eventually the limit switch cam 86 moving with the roller will reach the position shown in Fig. 9, in which the limit switch 84 is closed. The latter again causes energization of the adjusting motor 81, but this time in a direction to increase the speed of the in-feed roller 35 and to remove the tendency toward lagging. Motor 81 will, in addition, continue to rotate until the web 34 is drawn in at a rate sufficient to cause it to lead slightly, such lead, being detected by the photocell apparatus, to be described, resulting in movement of the compensator roller 37 to the left, opening of the limit switch 84 and a complete repetition of the above-outlined cycle.

The above sequence of adjusting operations will, in the present embodiment of my invention, normally occur even in the absence of accumulated error, the frequency of repetition depending primarily upon the rapidity with which the P. I. V. adjusting motor 81 produces a speed correction and upon the amount of lost motion or backlash in the limit switches 83, 84. Assuming that the speed is changed at a gradual rate and that sensitive limit switches are used, the corrective cycle can be caused to take place very slowly.

The fact that the registration adjustment may, and normally will, occur in cycles as described, produces a registration control which is "dynamic" in nature, constantly "seeking out" the

desired condition of registration. Such improved control is contrasted with prior art controls of the type which merely seek to maintain a condition of static equilibrium.

Detection of lag or lead

The mechanical means for driving the compensator roller to maintain the inserted web 34 in a position of registry with respect to the main webs 13, 15 have been already described. For satisfactory registration more is required than to energize the compensator adjusting motor 58 from time to time to restore registry: means must be provided for detecting the relative positional phasing of the pre-printed web and the main webs and such means must act in a continuous and repetitious manner. Means for accomplishing such continuous detection and for energizing the compensator adjustment motor 58 accordingly are shown to a limited extent in Fig. 1 and more particularly in Figs. 4, 5 and 6.

In the present embodiment detection of the instantaneous positioning of the web 34 is accomplished by means of a detecting photocell 44 (Fig. 1) which scans the edge of the web 34 and is actuated upon the passage of spots or markings 90 printed near the edge of the web at regularly spaced intervals. Such markings are arranged in a predetermined position with respect to the impression on the pre-printed web and are preferably placed thereon by one of the plate cylinders during the pre-printing operation. If desired, the web 34 may be illuminated in the vicinity of the photocell 44 by means of any suitable light source 91.

With regard to the means for detecting the instantaneous positioning of the main webs, this may be accomplished in any desired manner, for example, by the use of magnetic, electrical or photoelectric means for detecting the position of the shaft rotating in unison with the main webs. One possible scheme which may be used is shown near the right-hand edge of Fig. 1. Here it will be seen that the detector 46 includes a scanning cylinder 92 which is rotatably coupled to the shaft 19 which supports the folding and cutting cylinder 22. As previously stated, the latter cylinder is geared to the same power source which drives the plate cylinder; thus the instantaneous angular position of the shaft 19 is an accurate indication of the instantaneous positioning of the successive impressions on the main webs 13, 15.

The means provided for detecting the position of the scanning cylinder 92 may include sliding contacts as used in an alternate detection scheme to be later described in connection with Fig. 7. I prefer, however, to detect the positioning of the cylinder 92 by means of photocells 93, 94 and 96 which may be supported in any desired manner, as from a bracket 98 rigidly mounted on the frame 14. The photocells 93, 94 and 96 cooperate with light-reflecting strips or paths 100, 101 and 102 respectively which extend about the periphery of the cylinder 92 and reflect light into the associated photocell. Referring to Fig. 1, it will be noted that the light path 100 has a leading edge 103 which substantially corresponds in angular position to the trailing edge 104 of the light path 102, and the light paths are similarly related on the opposite side of the cylinder (not shown). In brief, this results in the timed alternate actuation of photocells 93 and 96 and is useful in determining whether the pre-printed web 34 is lagging or leading. Although the light paths

100, 101 and 102 have been shown as light strips on a darkened background, it will be apparent to one skilled in the art that only the difference in illumination is important and that darkened strips on a light background could also be readily utilized for purposes of detection.

The circuit for utilizing the outputs of the photocells for energizing the compensator adjusting motor is shown in simplified schematic form in an assumed "in register" condition in Fig. 4 and under conditions of "lag" or "lead" in Figs. 5 and 6 respectively. It will be understood, however, that my invention is not limited to the type of circuit shown in Fig. 4, but contemplates other arrangements which will appear to one skilled in the art for energizing the compensator adjusting motor 58 as required to bring the webs into registration.

It will be seen in Fig. 4 that each of the photocells 44, 93 and 96 has an associated amplifier 106, 108 and 110. The output circuits of such amplifiers include relays 111, 112 and 113 respectively to close an output circuit as the light falling on the photocell changes in intensity. As shown, the contacts 114 of relay 111 are in series with the supply lead to both contacts 116 of the relay 112 and contacts 118 of the relay 113. By this arrangement photocell 44 controls, by contacts 114, the application of voltage to the contacts 116 and 118 respectively associated with the "lag" photocell 93 and the "lead" photocell 96. The contacts 116 and 118 serve to energize field windings included within the compensator adjusting motor 58 which are connected respectively to input terminals 120 and 121 on the latter motor.

In understanding the control circuit thus far described let it be assumed that the input side of the contacts 114 is connected to a source of positive voltage. Triggering of the photocell 44 caused by the passage of a registering mark 90 causes the relay 111 to close, supplying voltage to the contacts 116 and 118. If under such conditions the photocell 93 should be actuated, the resulting closure of the contacts 116 would cause the compensator motor to turn in, say, a web-loosening direction. Alternatively, actuation of the photocell 96 by the light path 102 would cause closure of the contacts 118 and would cause the motor 58 to turn in the opposite direction.

With the scanning cylinder 92 in a position corresponding to registration between the webs (at least for the moment), it is desirable that the compensator adjusting motor remain motionless. Means are therefore provided for positively cutting off the power to the motor when the latter condition obtains. In the present instance this is accomplished by an auxiliary photocell 94 scanning the light path 101. As shown in Fig. 4, the light path 101 is continuous except for a short gap 122 substantially aligned with the edges 103, 104 of the light paths 100, 102 respectively. The auxiliary photocell 94 feeds into an amplifier 123, the output of which energizes relay 124 having contacts 126. With the latter contacts in the open position as shown in Fig. 4, it will be apparent that the path of current flow to the motor is interrupted. Thus, even if relay 112 or relay 113 should transiently close and cause chattering of the contacts 116, 118, the fact that the auxiliary photocell 121 is at such time centered within the gap 122 insures that contacts 126 will be open and that no power is supplied to the motor 58. If desired the auxiliary phototube may be dispensed with; the important part of the

circuit illustrated residing in the fact that photoelectric means close electrical circuits to energize the compensator adjusting motor 58 in a direction to restore registration.

For the purpose of ready understanding the compensator adjusting motor has been described as a simple direct current reversible motor operated directly by the relays in the plate circuits of the amplifiers. It will be understood by one skilled in the art, however, that contacts 116, 118 on the output relays could be employed instead to energize a relatively larger electrical contactor, the latter enabling the use of a heavy duty A.-C. or D.-C. reversible motor as desired. Also if desired the relays may be dispensed with and the well known Thyatron tubes used instead to obtain more rapid response. It will further be understood that the amplifiers 106, 108, 110 and 123 may be of any conventional type and may be supplied by any convenient type of photocell.

As stated above, the instantaneous position of the cylinder 92, with respect to the advancement of the web 34 and the contact positions of the various relays as illustrated in Fig. 4 correspond to a condition of assumed accurate registry between the webs. The conditions which exist when the pre-printed web 34 is appreciably lagging are illustrated in Fig. 5. In order to understand the lagging web condition it is necessary to define a "lagging" pre-printed web as one which is delayed with respect to the main press drive and the cylinder 92. Stated another way, the cylinder 92 under "lagging" conditions has advanced too far and leads the pre-printed web. Thus it will be noted that the light paths 100, 101 and 102 as shown in Fig. 5 are in advance of the position illustrated in Fig. 4. Under such conditions photocells 93 and 94 will be actuated resulting in closure of contacts 126 and 116. At this instant also, passage of the registering mark 90 on the pre-printed web 34 triggers the photocell 44 causing closure of contacts 114. The circuit to the compensator adjusting motor 58 is now complete and energization of the terminal 120 thereon causes the motor 58 to turn in a direction to move the compensator roller 37 (Fig. 3) to the right. This causes loosening of the web and corrects the condition of lag.

Fig. 6 is similar to Fig. 5 except that it shows the opposite condition in which the pre-printed web appreciably leads the main web. Stated another way, the angular position of the cylinder 92, at the instant that the photocell 44 is triggered by the passage of a registering mark 90, is angularly retarded and lags the position which should exist to satisfy the condition of accurate registry. As shown in Fig. 6, the photocells 94 and 96 under such conditions are actuated by the light paths 101 and 102 respectively, closing contacts 126 and 118 at the outputs of their associated amplifiers. The passage of the registering mark 90 on the web 34 simultaneously causes closure of the contacts 114. As the result, voltage is applied to terminal 120 of the compensator adjusting motor 58 causing the latter to rotate in a direction to move the compensator roller 37 (Fig. 3) to the left thereby tightening the web and, at least temporarily, correcting the condition of leading web.

In the above description and in the drawings the light paths 100, 101 and 102 have been shown applied to a cylinder. It will be readily appreciated, however, that such light paths could also be placed instead on a flat disk mounted on the

shaft 19 or, as a matter of fact, on any of the shafts in the press to which shaft 19 is positively geared. Mounting the rotating element 92 on the shaft 19 does, however, have the advantage that difficulties arising from backlash in the gears of the press are to a great extent minimized.

Modification of detector utilizing commutating contacts

Rather than using photocells 93, 94 and 96 to detect the angular position of the folding and cutting cylinder 22, it is possible to use sliding electrical contacts for this purpose. The latter arrangement is shown in Fig. 7. In this embodiment a cylinder 92a carries three electrically interconnected conducting strips 100a, 101a and 102a. The conducting strips 100a and 102a are arranged on the cylinder in a manner completely analogous to the light paths 100 and 102 referred to in connection with the previous embodiment. The strip 101a extends continuously around the cylinder serving as a source of voltage for the strips 100a and 102a. Stationary contacts 93a and 96a bear upon the latter strips and supply voltage to terminals 120 and 121 on the compensator adjusting motor 58.

In order to produce a positive removal of electrical power from the motor when the cylinder 92a is in a proper relative position of registry, a cam switch 130 is used which may be coupled to the shaft 19, the latter taking the place of photocell 94 and its associated circuit. For the greater part of the revolution contacts 131 on the cam switch 130 remain closed; they are opened only during the short interval in which the cylinder 92a is at an angular position corresponding to the position of registry. The means for detecting the passage of a registering mark 90 on the pre-printed web 34 and for applying voltage to the motor supply circuit is exactly the same as that which has already been discussed in connection with Figs. 4, 5 and 6.

With regard to the operation of the device shown in Fig. 7, passage of a registering mark 90 will cause closure of contacts 114. With the cylinder 92a in a temporary position of accurate registry as shown, the contacts 131 will be open and the compensator adjusting motor 58 will therefore remain stationary. Should the web 34 be out of registry even slightly, closure of the contacts 114 would occur during a time when contacts 131 were closed and while one or the other of the stationary contacts 93a, 96a were in contact with one of the conducting strips 100a, 102a. Under such circumstances one or the other of the two terminals 120, 121 would be momentarily energized and the motor 58 would rotate to drive the compensator roller 37 either to the right or to the left, depending upon the sense of the correction required. For further details of a detector arrangement of the latter type, reference is made to United States Letters Patent No. 2,105,185, issued January 11, 1938.

Summary of operation

Although the operation of the registration control system (using the circuit of Fig. 4) will be apparent from the foregoing, it may be summarized briefly as follows:

It will be recalled that the system has been characterized as "dynamic", that is, the nature of the control is such that it does not normally occupy a position of static equilibrium. This results from the fact that a given one of the limit

switches 83, 84 causing a corrective change in speed is deenergized only after the speed has been over-corrected. The latter produces frequent, step by step, energization of the compensator roller adjusting motor 58 to move the roller 37 in the direction of its other limit position.

The positions of the control relay contacts during the condition of perfect registry (and between corrective steps of energization of the motor 58) is shown in Fig. 4. Here it is assumed that the photocell 44 is being triggered by one of the registering marks 90 which are spaced along the edge of the web 34 and that the contacts 114 of the associated relay are momentarily closed. It is also to be noted that the light path 101 is in an off or "null" position with respect to photocell 94. Contacts 126 on relay 124 therefore will be open at the instant that contacts 114 are closed, and under such circumstances no voltage can appear at the compensator adjusting motor 58 to change the adjustment of the compensator roller 37, the latter momentarily remaining stationary.

If, regardless of the reason, the pre-printed web tends to lag the position of registry, closure of the relay contacts 114 will occur at an instant when contacts 126 and contacts 116 are also closed (see Fig. 5). The latter will cause the compensator adjusting motor 58 to be energized for rotation to slacken the web 34 as necessary to temporarily reestablish the condition of registry. Likewise, if the web for any reason tends to lead the position of registry, photocells 94 and 96 will cause closure of contacts 126 and 118 respectively energizing the adjusting motor 58 to tighten the web to compensate temporarily for the lead. The latter condition is illustrated in Fig. 6.

Cumulative error, caused by short printing or the like, merely results in cumulative movement of the compensator roller. As the limit of movement is reached, the limit switch cam 86, which moves with the compensator roller 37 in its path of adjustment, causes operation of limit switch 83. As shown in Fig. 8 the latter energizes the P. I. V. adjusting motor 81 for rotation in a direction to decrease the speed of the in-feed roller 35. Speed reduction will continue at a slow rate until the photocells and associated circuits detect the fact that the web 34 is tending to lag to a slight extent rather than to lead. Even a small amount of lag will be reflected in energization of the compensator adjusting motor 58 in a direction to move the compensator roller 37 to the right and therefore out of contact with the limit switch 83. Thereafter further bodily movement of the compensator roller will take place either to the right or to the left as necessary to compensate for small amounts of lead or lag of the pre-printed web and in a manner completely unaffected by accumulation of the error.

In the event that a large initial amount of mis-registration exists upon starting of the press or as the result of splicing the web, this will merely result in energization of the compensator motor to rotate in one direction or the other until the mis-registration has been completely corrected. Accordingly, it is desirable that the range of adjustment of the compensator roller 37 be approximately the cyclic length of one printed impression thereon. Since the light paths 100, 102 each extend only one-half the distance around the cylinder 92, movement of the compensator roller will always take place in a direction in which registration can be established with a minimum

13

amount of adjusting movement. It is impossible for the registration control which has been described to become "lost" regardless of the magnitude of the misregistration which may exist.

It will be apparent to one skilled in the art that the invention is not limited to a case where a single speed motor is used for adjusting the compensator roller 37 but obviously includes arrangements in which motors having higher speeds may be used in order to achieve registration in a minimum amount of time. The latter is particularly advantageous where it is desired to correct large amounts of initial misregistration with a minimum of wasted copies.

Although the invention has been described only in connection with one inserted web, it will be apparent that the teachings herein are not so limited. By using another set of apparatus a second web may be inserted simultaneously with the same speed and accuracy. Further, any of the inserted webs may be entered at any desired point in the main press and not necessarily immediately prior to the main draw roller as illustrated.

As a further refinement the pre-printed web may be printed to have a cyclic length very slightly longer than the main webs, enabling the web to be fed under reduced average tension and the chances of web breakage minimized.

In the following claims, the term "compensator roller" will be interpreted as including non-rotatable polished bars as well as rotatable rollers for lengthening or shortening the web loop.

I claim as my invention:

1. In a web feed printing press, the combination of a folder having a rotary cut-off device, means for leading a web from a printing unit to said folder, means including an in-feed roller driven by a variable speed drive mechanism for supplying a pre-printed re-rolled web having spaced marks thereon to associate with the first mentioned web preparatory to entering said folder, a compensator roller over which the pre-printed web is led prior to its association with said first mentioned web, means supporting said compensator roller for bodily adjustment between alternate limit positions, means operable in response to variations in relative positional phase of the marks on said pre-printed web and of said rotary cut-off device for correctively adjusting the position of said compensator roller, and means responsive to approach of said compensator roller to one of its alternate limit positions for correctively varying the speed of said variable speed drive mechanism for said in-feed roller.

2. In a web feed printing press, means for combining a first web having spaced registering markings thereon with a second web in a position of registry with successive impressions on the latter, said means comprising an in-feed roller for supplying said first web, variable feed drive mechanism for driving said in-feed roller, a compensator roller over which said first web is led prior to its association with said second web, means for effecting transverse bodily adjustment of said compensator roller between two extreme positions, means operable in response to variations in the relative positional phase of successive marks on said first web and of the impressions on said second web for correctively adjusting said compensator roller, and means responsive to the approach of said compensator roller to one of its alternate limit positions for correctively varying the speed of said variable speed drive mechanism.

3. In a device for maintaining registry between

14

a first web and a second web, means including a compensator roller associated with at least one of said webs and having alternate limits of travel, in-feed means associated with at least one of said webs for varying the speed thereof, detecting means responsive to variations in the relative positional phasing of said webs for correctively adjusting said compensator roller in a direction to produce registry of said webs, means actuated by said compensator roller means as an incident to the latter's approaching one of its alternate limits of travel for initiating a change in the speed of said in-feed means which is sufficient in magnitude and of proper direction to cause movement of said compensator roller away from the said one of its limits of travel and toward said other limit of travel.

4. In a device for maintaining registry between a first web and a second web, means for combining said webs in face-to-face contact, means including a compensator roller associated with at least one of said webs for forming a loop in one of said webs ahead of said combining means and having alternate limits of travel, means associated with at least one of said webs for varying the speed thereof, detecting means responsive to variations in relative positional phasing of said webs, means actuated by said detecting means for correctively adjusting said compensator roller in a direction to produce registry of said webs, and means controlled by said compensator roller initiating a corrective adjustment in said speed varying means as an incident to said compensator roller approaching one of its alternate limits of travel.

5. In a web feed printing press, the combination of a folder having a rotary cut-off device, means for leading a web from a printing unit to said folder, means including an in-feed roller driven by a variable speed drive mechanism for supplying a pre-printed re-rolled web having spaced registering marks thereon to associate with the first mentioned web preparatory to entering said folder, a compensator roller over which the pre-printed web is led prior to its association with the first mentioned web, means supporting said compensator roller for bodily adjustment between alternate limit positions, means including a photocell operable in response to variations in relative positional phase of the marks on said pre-printed web and of said rotary cut-off device for correctively adjusting the position of said compensator roller, and means responsive to approach of said compensator roller to one of its alternate limit positions for correctively varying the speed of said variable speed drive mechanism for said in-feed roller.

6. In a web feed printing press, the combination of a folder having a rotary cut-off device, means for leading a web from a printing unit to said folder, means including an in-feed roller driven by a variable speed drive mechanism for supplying a pre-printed re-rolled web having spaced marks thereon to associate with the first mentioned web preparatory to entering said folder, a compensator roller over which the pre-printed web is led prior to its association with said first mentioned web, means supporting said compensator roller for bodily adjustment between alternate limit positions, means operable in response to variations in relative positional phase of the marks on said pre-printed web and of said rotary cut-off device for correctively adjusting the position of said compensator roller, and means including limit switches operated as

an incident to the approach of said compensator roller to one of its alternate limit positions respectively for correctively varying the speed of said variable speed drive mechanism for said in-feed roller.

7. In a web feed printing press, the combination of a folder having a rotary cut-off device, means for leading a web from a printing unit to said folder, means including an in-feed roller driven by a variable speed drive mechanism for supplying a pre-printed re-rolled web having spaced registering marks thereon to associate with the first mentioned web preparatory to entering said folder, a compensator roller over which the pre-printed web is led prior to its association with the first mentioned web, means supporting said compensator roller for bodily adjustment between alternate limit positions, detecting means including a photocell successively triggered by the passage of said marks, means operating in timed relation with said cut-off cylinder and actuated by said mark detecting means for producing an output signal in accordance with the lag or lead of successive ones of said marks with respect to the position of said cut-off cylinder, means responsive to said output signal for bodily adjusting the compensator roller in a direction to correct said lead or lag, and means responsive to the approach of said compensator roller to one of its alternate limit positions for correctively varying the speed of said variable speed drive mechanism for said in-feed roller.

8. In a web feed printing press, the combination of a folder having a rotary cut-off device, means for leading a web from a printing unit to said folder, means including an in-feed roller driven by a variable speed drive mechanism for supplying a pre-printed re-rolled web having spaced registering marks thereon to associate with the first mentioned web preparatory to entering said folder, a compensator roller over which the pre-printed web is led prior to its association with said first mentioned web, means supporting said compensator roller for bodily adjustment between alternate limit positions, mark detecting means including a photocell successively actuated by the passage of said marks, means rotating in unison with said cut-off cylinder and having alternate light paths thereon, means including lead and lag photocells for scanning said light paths respectively, means responsive to the simultaneous actuation of said mark detecting photocells and one of said lead and lag photocells for correctively adjusting the position of said compensator roller, and means actuated upon the approach of the compensator roller to one of its alternate limit positions for initiating a corrective change in speed of said variable speed drive.

9. In a web feed printing press, the combination of a folder having a rotary cut-off device, means for leading a web from a plate cylinder to said folder, means including an in-feed roller driven by a variable speed drive mechanism for supplying a pre-printed re-rolled web having spaced registering marks thereon to associate with the first mentioned web preparatory to entering said folder, a compensator roller over which the pre-printed web is led prior to its association with said first mentioned web, means supporting said compensator roller for bodily adjustment between alternate limit positions, mark detecting means including a photocell successively actuated by the passage of said marks, means rotating in unison with said cut-off cylinder and having alternate light paths thereon, means in-

cluding lead and lag photocells for scanning said light paths respectively and for alternate actuation thereby, means responsive to the simultaneous actuation of said mark detecting photocell and one of said lead and lag photocells for correctively adjusting the position of said compensator roller, and means responsive to the approach of said compensator roller to one of its alternate limit positions for correctively varying the speed of said variable speed drive mechanism for said in-feed roller.

10. In a web feed printing press, means for combining a first web having spaced registering markings thereon with a second web in a position of registry with successive impressions on the latter, said means comprising an in-feed roller driven by a variable speed drive mechanism for supplying said first web, variable feed drive mechanism for driving said in-feed roller, a compensator roller over which said first web is led prior to its association with said second web, means supporting said compensator roller for bodily adjustment between alternate limit positions, mark detecting means including a photocell successively actuated by the passage of said markings, means rotating in step with the impressions on said second web and having alternate light paths thereon, means including lead and lag photocells for scanning said light paths respectively and for alternate actuation thereby, means responsive to the simultaneous actuation of said mark detecting photocell and one of said lead and lag photocells for correctively adjusting the position of said compensator roller, and means responsive to the approach of said compensator roller to one of its alternate limit positions for correctively varying the speed of said variable speed drive mechanism for said in-feed roller.

11. In a device for maintaining registry between a first web and a second web, means for combining said webs in face-to-face contact, means associated with said first web for producing a normal running tension therein on the intake side of said combining means, means in contact with said second web for varying the tension therein on the intake side of said combining means and having alternate limits of adjustment, means associated with at least one of said webs for varying the in-feed speed thereof, detecting means responsive to variations in relative positional phasing of said webs, means actuated by said detecting means for correctively adjusting said tension varying means to make the tension in said second web either greater or less than the tension in said first web thereby to produce registry of said webs, and means initiated by said tension varying means approaching one of its limits of adjustment for correctively adjusting said speed varying means.

12. In a device for maintaining registry between a pre-printed web and a group of conventional webs in a printing press comprising, in combination, a set of combining rollers for combining all of the webs in face-to-face contact, a pair of in-feed rollers for said pre-printed web and spaced from said combining rollers to define a loop of pre-printed web, compensator means for pressing outwardly on said loop of web to place said loop under tension and thereby slightly elongate the same, detector means cooperating with said pre-printed web at a point ahead of said combining rollers for detecting the phasing of the impression on the pre-printed web relative to the remainder of said webs, means

17

actuated by said detecting means for correctively adjusting said compensator means for varying the tension and therefore the length of said loop in a direction to produce registry of said pre-printed web, and means initiated by the approach of said compensator means to one of its limits of adjustment for correctively changing the speed of said in-feed rollers relative to the speed of the combining rollers to maintain a condition of register.

CURTIS S. CRAFTS.

REFERENCES CITED

The following references are of record in the file of this patent:

10

Number
2,041,602
2,052,263
2,105,185
2,118,816
2,230,715
2,375,451

18

UNITED STATES PATENTS

Name	Date
Grozier -----	May 19, 1936
Whiteley -----	Aug. 25, 1936
Degnan -----	Jan. 11, 1938
Lamatch et al. -----	May 31, 1938
Cockrell -----	Feb. 4, 1941
Waters -----	May 8, 1945

FOREIGN PATENTS

Number	Country	Date
320,885	Great Britain -----	Oct. 18, 1929

15