

Sept. 3, 1963

F. G. AUER ETAL
MULTIPLE CORRECTION REGISTRATION SYSTEM
FOR MULTI-COLOR PRINTING PRESS

3,102,471

Filed April 3, 1961

3 Sheets-Sheet 1

FIG. 1

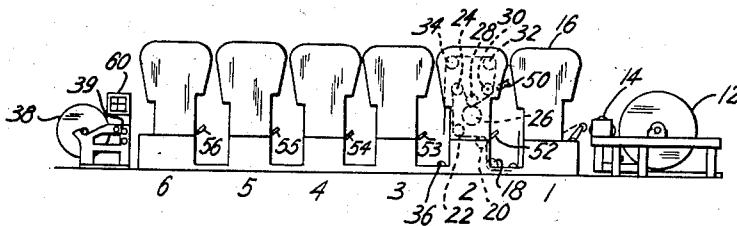


FIG. 2.

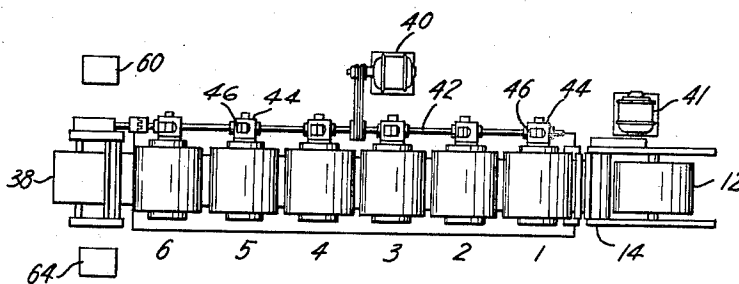
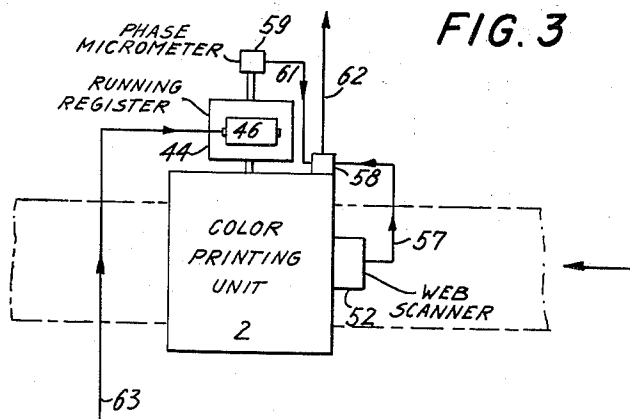


FIG. 3



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FIG. 4

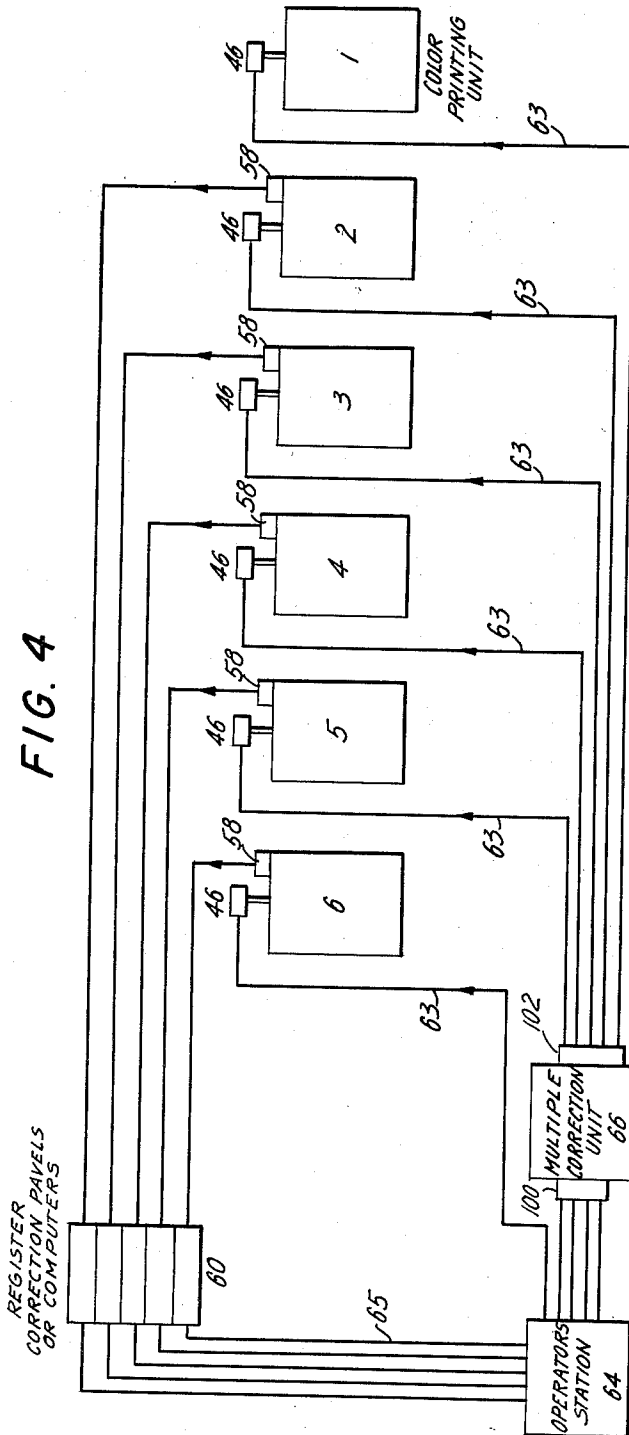
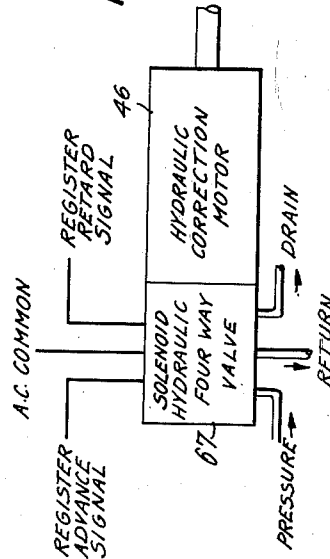


FIG. 5



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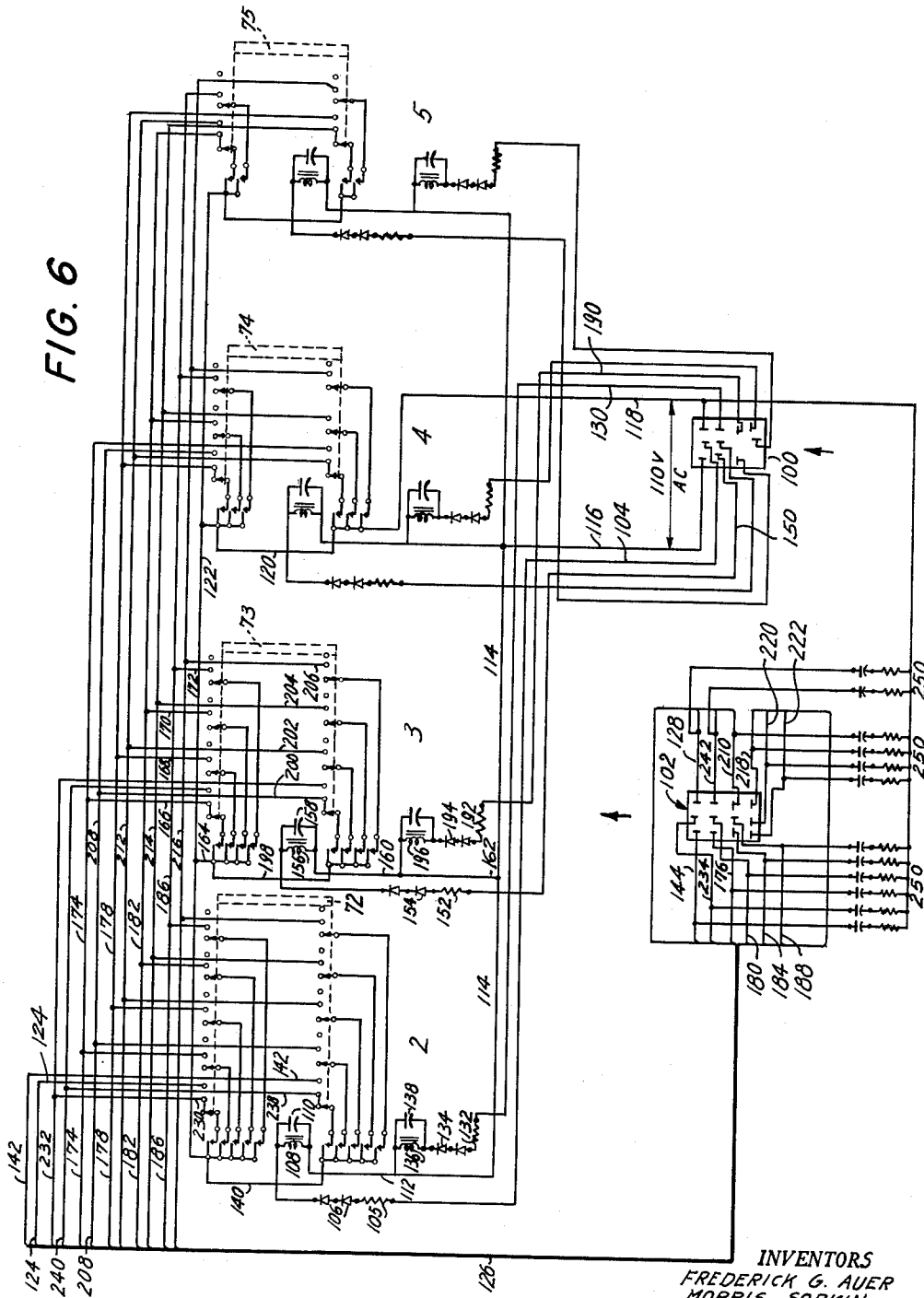
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3 Sheets-Sheet 3



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3,102,471

MULTIPLE CORRECTION REGISTRATION SYSTEM FOR MULTI-COLOR PRINTING PRESS

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13 Claims. (Cl. 101—181)

This invention relates to registration systems for operating on a moving web, and more particularly to a multiple correction registration system for multi-color printing presses.

It is already known to provide the color units of a multi-color printing press with registration correction gearing including a reversible correction motor at each color unit for introducing an advance or retard correction. It is also common to provide an electric eye scanner and computer circuitry for each color unit (except the first) for detecting an error in registration in order to automatically control the correction motor at its local color unit.

We have found that the introduction of a correction at one station or color unit affects the succeeding stations or color units. The stations are interconnected by the taut web, with resulting instability because a correction at one color unit may set off a chain of corrections at succeeding color units. The general object of the present invention is to improve registration systems by increasing the stability thereof.

From a different viewpoint, an object is to reduce the waste of web caused by incorrect registration, which may be very costly when dealing with a high speed press handling expensive web material.

We have found it possible to greatly reduce press waste by making a correction not only at the unit in which an out of register condition has been sensed, but also making the same correction simultaneously at all following color stations. We observed that after a register correction was made, all succeeding electric eye systems became "nervous" and active. We believe this can be explained by the fact that if station 2 makes an advance correction, the web tension between units 2 and 3 becomes less, allowing station 3 to feed more web. This condition usually calls for a number of premature correction impulses, resulting in false correction and hunting. By making a simultaneous correction on all following units, uniform tension is maintained and false corrections are eliminated. However, we do not wish to be bound by this theory. On all presses on which the improvement has been tested there has been a very marked reduction in waste, particularly when a splice passes through the press, or during startup, and also when changes in press speed have been made. For convenience this type of correction may be called "feed forward."

In accordance with a further feature and object of our invention, an electric eye scanner and computer on a second color unit is used to feed a correction back to the first color unit, instead of being used as usual in the second color unit. The desirability of doing this may be considered to be an empirical discovery, and we do not wish to be bound by any theory advanced to help explain the advantage. Our theory, which may or may not be correct, is that a web before and at the first color unit is subjected to a number of variables, whereas by the time the web reaches the second color unit it is in a more stable condition. A web passing through the first color unit receives ink for the first time. It is subjected to the heat of the gravure drier for the first time. It is subjected to compression between the gravure cylinder and its impression roll for the first time. These may all contribute to some change in "repeat length" of the web, but

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without similar changes taking place thereafter. Corrections made at the first unit help anticipate these changes. For convenience this type of correction may be termed "feed back."

Such feed back also reduces waste due to unavoidable variation of repeat lengths on press infeed. If the layoff of the key color varies for any reason whatsoever, such as change in moisture content, density, board caliber, etc., all other color units will go out of register and will have to be corrected. This generally brings about instability throughout the press, causing over-correction which results in a hunting condition. We find that this instability can be reduced by making the second color the fixed or so-called key color, and correcting the first color for misregister. In order to use this system, it is desirable to have a register mark on each of the engraving cylinders, or at least on the first two cylinders. Heretofore a register mark frequently was made on only the first color station. This technique has been field tested, and excellent results have been obtained.

Still another object is to provide circuitry for the printing press which will afford great flexibility in the use of the different units of the press line. For example, suppose three colors are being printed on a six-color press. The operator may decide to use color units 4, 5, and 6, in which case station 5 must feed back to station 4, instead of station 2 feeding back to station 1. For special purposes it may be desired to provide feed forward without feed back, or vice-versa, as well as both together as we prefer. It is also possible to completely bypass the multiple correction circuitry, and to reestablish conventional operation whereby each scanner controls the correction motor of its station alone, as when servicing or working on the multiple correction circuitry.

To accomplish the foregoing general objects, and other more specific objects which will hereinafter appear, our invention resides in the apparatus elements and their relation one to another, as are hereinafter more particularly described in the following specification. The specification is accompanied by drawings in which:

FIG. 1 is an elevation showing a six-color printing press;

FIG. 2 is a plan view of the same;

FIG. 3 is a diagrammatic plan view of one of the color units;

FIG. 4 is a diagram, in block form, explanatory of the apparatus;

FIG. 5 schematically represents one of the reversible correction motors; and

FIG. 6 is a detailed wiring diagram of the multiple correction circuitry provided in one of the blocks in FIG. 4.

Referring to the drawing, and more particularly to FIGS. 1 and 2, we there show a multi-color printing press of the high speed rotogravure type, there being in this case six color units marked 1, 2, 3, 4, 5, and 6. The web is taken from a suitable supply roll 12, from which it is pulled by a pull unit 14. The color units are each surmounted by a drier hood 16. In the absence of printing on the reverse side of the web, the path of the web is the same in each of the units, and is here illustrated in the second color unit. The web is guided over rollers 18, 20, 22, and 24 to a printing couple made up of a gravure cylinder 26 and an impression roller 28. The printed web then is guided around guide rollers 30, 32, 34, and 36. On leaving the last color unit the web may run to any other machine for operation on the web, or the web may be rolled up as here indicated by takeup roll 38. A pull unit 39 usually is disposed between the last color unit and the takeup roll.

Referring now to FIG. 2, the six color units are all driven in unison by means of a main drive motor 40 con-

nected to a main drive shaft 42 which runs along the press line. A separate motor 41 may drive the feed unit 14. Shaft 42 is geared to the individual color units by gearing housed at 44. This preferably includes differential gearing which makes it possible to feed an advance or retard correction into the printing cylinder, such a gearing being known as a "running register." The extra motion or correction is provided by a remotely controllable reversible correction motor shown at 46. However the correction could be provided by a compensating roller which lengthens or shortens a loop or web between color units, and in that case the correction again is introduced by means of a remotely controllable reversible correction motor, so that the system here described is applicable to either type of correction gearing.

Considering the "feed back" feature of the invention, the multi-color printing press comprises at least two color units, 1 and 2, the first of said color units having registration correction gearing 44, including a remotely controllable reversible correction motor 46 for introducing an advance or retard correction at the first color unit. The second color unit has an electric eye scanner 52 (FIG. 1) and computer circuitry 60 for detecting an error in registration. There is also circuitry, to be described later, between computer 60 and motor 46, whereby an error in registration at unit 2 causes appropriate operation of the correction motor 46. Such operation is in reverse sense.

Considering next the "feed forward" feature of the invention, the printing press of FIGS. 1 and 2 comprises a series of color units, each of which has registration correction gearing including a remotely controllable reversible correction motor. Color unit 3 has an electric eye scanner indicated at 53 and a computer at 60, which helps detect a registration error at unit 3. This color unit is followed by additional color units, in this case units 4, 5, and 6. There is circuitry, described later, whereby an error in registration operates not only the correction motor of color unit 3, but simultaneously operates the correction motors of the succeeding color units, in this case 4, 5, and 6 as well as unit 3. However, it does not affect preceding units 1 and 2.

Moreover, in accordance with our invention the circuitry is such that an error in registration at color unit 4, detected with the aid of scanner 54, operates the correction motor of color unit 4 and simultaneously operates the correction motors of color units 5 and 6. There is no effect on units 1, 2, and 3. Similarly an error detected with the help of the scanner 55 of color unit 5 operates the correction motors of color unit 5 and of color unit 6. There is no effect on preceding units 1, 2, 3, and 4. Of course the scanner 56 of color unit 6 controls only its local correction motor, in accordance with past practise, but that is so only because it is the last color unit. We have installed the present invention in presses having eight color units, and in such case the scanner of color unit 6 controls its correction motor and the correction motors of units 7 and 8, and so on.

The novel multiple correction circuitry of the present invention is shown in detail in FIG. 6 of the drawing. However in order to show the location of this new circuitry in the older or conventional systems, reference may be made to the block diagram of FIG. 4, which represents the six color units. To better understand FIG. 4, reference may be made to the schematic diagram for a single-color unit shown in FIG. 3.

Referring to FIG. 3, a multiple wire cable 57 runs from scanner 52 to a connector 58. The mark which is scanned is that put down by some preceding press, and it is compared with the position of the local gravure cylinder, here indicated by a so-called "phase micrometer" 59 which is on the cylinder shaft, the system here used being assumed to be the commercial model C-300 model or C-300-1 "Registron" manufactured by Champlain Company, Inc. of Roseland, New Jersey. For the present

purpose it may be said that the phase micrometer is much like that disclosed in U.S. Patent 2,888,260 of George J. Schowerer and Morris Sorkin, issued May 26, 1959, and entitled "Registration Control Apparatus." However, the system in that patent corresponds to a model C-293 of said Champlain Company, Inc. The present invention is applicable to these and any other registration system which detects an error and provides a correction signal.

In this case a register unit may be said to comprise the scanner or electric eye 52, the phase micrometer 59 which produces a reference or measuring signal for comparison and a gating signal to select the proper register target, a register correction circuit which we refer to as the "computer," not shown in FIG. 3 but indicated at 60 in FIGS. 2 and 4, and a correction motor 46, which usually operates a running register 44 but which could operate a compensating roller. A multi-wire cable 61 leads from phase micrometer 59 to the connector 58, and a multi-wire cable 62 then runs from connector 58 to the register correction circuitry or computer. The latter provides a motor control signal which is led through a multi-wire cable 63 to the correction motor 46.

The connections at 58 preferably employ detachable connectors, for ease in servicing. Provision may be made for manual control to supersede the automatic control, and in such case an operator's station may be provided, indicated at 64 in FIG. 2. It will be understood that the computer panels 60 and the operator's station 64 may be combined and located at one point.

Referring now to FIG. 4, the computers or correction panels are shown at 60, and the outputs are fed through conductors 65 to an operator's station 64. Heretofore cables then ran from the operator's station to the correction motors and running registers indicated at 46. However, in accordance with our invention the new multiple correction circuitry is interposed, as indicated by the block 66. Connection may be made by a multiple prong detachable input connector 100 and a multiple prong detachable output connector 102.

As in FIG. 3, the cables from the web scanner (not shown) and the phase micrometer (not shown) are combined in a connector 58, and cables from connectors 58 lead to the individual computers or register correction panels shown at 60. Assuming no manual intervention at the operator's station, the correction signals go from computers 60 to the multiple correction unit 66 and thence to the correction motor 46.

Usually there is a running register on every drive box or press unit. There is a scanner on all units except unit 1 which has no scanner nor phase micrometer because there is no register marker and therefore nothing to scan. Theoretically with our system there would be no need for a running register on unit 2, but it is used, first, so that the units will be interchangeable; second, so that when less than six colors are used any of the units may be selected for use; and third, for convenience when first setting up for a new printing job. (By analogy, in the old system there would be no need for a running register on unit 1, but one was used for convenience in setting up a new job.)

The correction motors 46 may be reversible electric motors. The cables 63 provide for advance or retard, and an ordinary three-wire system is adequate. In preferred form the motors are hydraulic motors, and the only difference then is that the three-wire electrical system controls the hydraulic valve of the motor. This is shown schematically in FIG. 5, in which hydraulic correction motor 46 is controlled by a solenoid operated hydraulic four-way valve 67. The three electrical conductors are shown at the top, and provide advance and retard wires, and a common return wire. The system may be A.C. or D.C., and in the present case happens to be A.C. The piping to the four-way valve provides for supply or pressure, and for return, and drain, all in accordance with conventional hydraulic practise.

By way of preliminary introduction to FIG. 6 it may

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be explained that the multiple correction unit is made quite universal in character. For example, normally station 2 feeds back a correction to station 1, but in the present circuit any station (except 1) can feed back to its preceding station. This is done for the reason previously given. For example, suppose three colors are being printed instead of six. The operator may decide to use color units 4, 5, and 6, in which case unit 5 must feed back to unit 4. In a different case he may elect to use four colors or units 2, 3, 4, and 5, in which case unit 3 must feed back to unit 2.

In addition there is the main "feed forward" or multiple correction, whereby with all six units operating, a correction at unit 3 is fed forward also to units 4, 5, and 6; a correction at unit 4, in addition to itself, is fed forward to units 5 and 6; and a correction at unit 5, in addition to itself, is fed forward to unit 6. There is no feed forward provision for unit 6 because it has nothing to feed forward to, but in the eight-color unit there would be feed forward except from unit 8.

There is switching in the circuitry to permit feed forward without feed back; to permit feed back without feed forward; and to eliminate both. Thus unit 2 can feed forward instead of back. Another feature, primarily for ease in servicing, is that the input connector 100 (FIG. 4) may be joined directly to the output connector 102, thereby completely by-passing the multiple correction unit 66, and reestablishing old style operation where the scanner and computer of each color unit corrects that unit only.

Referring now to FIG. 6 (the wiring of unit 66), the connector 100 receives the correction signals, which are either "advance" or "retard," for any one of the units 2, 3, 4, and 5. These are fed to relays and switches in groups marked 2, 3, 4, and 5, for the corresponding stations 2, 3, 4, and 5.

In group 2 attention is directed to a ten pole, three-position switch shown to the right of relay 108. In the diagram the switch poles are shown slidable from left to right, there being five poles at the top and five poles at the bottom, all moved in unison by control means schematically represented by the dotted line bar 72. (The other switches are moved by bars 73, 74, and 75.) The stationary contacts of the switch must be considered in groups of three, and the switch is movable between a left hand position, a middle position, and a right hand position. In the drawing all switches are shown in the left hand position. In the left position the circuit provides normal or localized operation; in the middle position the correction is fed forward; and in the right position the correction is fed back. The actual switch may be a rotary switch, in structure, controlled by a rotatable knob.

It will be noted that there are only four such switches, and that they are not all alike, but begin to have less poles moving toward the right or higher numbered units. There are only four switches because color unit 1 requires none, and color unit 6 requires none. There are ten poles for color unit 2 (five for advance and five for retard) because it can correct unit 2 and feed forward to units 3, 4, 5, and 6; there are eight poles for unit 3 because it can correct unit 3 and feed forward to units 4, 5, and 6; there are six poles for unit 4 because it can correct unit 4 and feed forward to units 5 and 6; and four poles for unit 5 because it can correct unit 5 and feed forward to only unit 6. Each switch is preceded by upper and lower relays for "advance" and "retard" respectively, as described later. All relays shown in FIG. 6 are normally open when deenergized.

Assuming unit 2 is used for feed back, the switch 72 is in its right hand position, that is, all ten poles or arrows are shifted to the right to the third contact in the groups of three. If a correction calls for "advance," meaning that the gravure printing cylinder of unit 2 should be speeded momentarily, then when using feed back this

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means instead that gravure cylinder 1 should be retarded or slowed momentarily, which accomplishes the same thing relative to the web. The "advance" signal comes in from connector 100 to conductor 104 which leads to a limiting or surge preventing resistor 105 and a rectifier 106 (the signal here being A.C.), and thence to upper relay coil 108, shunted by a capacitor 110 which filters in cooperation with rectifier 106, and from relay coil 108 to common return 112, 114, 116, back to the connector 100.

With relay 108 energized, the relay contacts thereabove are pulled in (down); that is, the contacts are closed. Current then flows through hot lines 118, 120, and 122 to the top relay contact, and thence through the first (upper left) switch pole to the right hand switch contact (of the first three contacts) upward to conductor 124 and thence through the multi-wire cable or harness 126 to individual or separated conductor 128 and so to connector 102. This provides a register retard signal for unit 1.

The electric eye and computer system of printing unit 2 may call for "retard," which corresponds to an "advance" correction required in unit 1. This is obtained as follows. The "retard" signal from unit 2 flows through conductor 130 to resistor 132 and rectifier 134, thus energizing the coil of lower relay 136, which again is shunted by a filter condenser 138. The relay return is through common return conductors 114 and 116 as before. When the relay 136 is energized the contacts thereabove are pulled in (down), which sends a signal starting at the hot side 118 of the A.C. line through conductors 120 and 122 to conductor 140 to the top relay contact, and thence through the switch which at this time is in its right hand position. Current therefrom flows through conductor 142, cable 126, and conductor 144 to the connector 102, from which an "advance" signal runs to the correction motor of unit 1.

Without tracing the wiring in detail it may be explained that if the three-position switch 73 of unit 3 is placed in the right hand switch position the same operation will ensue, with the correction signal of unit 3 becoming reversed in sense and fed back to unit 2. Similarly in unit 4 if the three-position switch 74 is put in the right hand switch position a correction signal from unit 4 will be reversed in polarity and fed back to unit 3, and so on.

If we assume a normal operating condition in which unit 2 feeds back to unit 1, and unit 3 provides a registration correction for itself and the succeeding units 4, 5, and 6, then the three-position switches of units 3, 4 and 5 are all placed in the middle switch position. If now an "advance" correction comes from printing unit 3 to connector 100, current flows through conductor 150 to resistor 152 and rectifier 154 to energize the relay coil 156, which again is preferably shunted by a capacitor 158. The return from the relay coil is through conductors 160 and 162 to the common return 114, 116, previously mentioned. This pulls the relay contacts thereabove in (down).

With the top relay contact down, current flows from the hot lines 118, 120, 122 through line 164 and the four relay contacts to all four switch poles which then are in the middle switch position, so that current flows through conductors 166, 168, 170 and 172. It will be recognized that there are four lines because at this time correction is to be applied to unit 3 itself and simultaneously to the following three units 4, 5 and 6.

For this purpose line 166 continues through 174, cable 126 and wire 176 to connector 102, whence the correction current is fed to the correction motor of unit 3 for advance correction (there being no reversal in sense for feed forward as there is for feed back). Similarly, line 168 connects to 178, cable 126 and wire 180. Also wire 170 connects to line 182, cable 126 and wire 184. Also wire

172 connects to line 186, cable 126 and wire 188. The appropriate contacts of connector 102 lead to the correction motors of units 4, 5 and 6 respectively, for advance correction.

If instead the electric eye circuitry of unit 3 calls for a "retard" correction, current flows from connector 100 through line 190, resistor 192, and rectifiers 194 to relay coil 196, so that the relay contacts thereabove are pulled in. The current from relay coil 196 returns through conductor 162 and the common return 114, 116 previously mentioned.

When the "retard" relay 196 is pulled in, current flows from hot lines 118, 120, 122, 164, 198 to the bank of four lower relay contacts. Current then flows through the four lower switch poles (then in the middle switch position) to the conductors 200, 202, 204 and 206. Conductor 200 leads through line 208, cable 126, and wire 210 to connector 102, the appropriate contact of which leads to the correction motor of unit 3 for a "retard" correction. In similar fashion wires 202, 204 and 206 lead to lines 212, 214, and 216 respectively, and thence through cable 126 to wires 218, 220, 222 to connector 102 for a "retard" correction for units 4, 5 and 6 respectively.

Without going into as much detail, it will be found that the operation for unit 4 is the same when a correction signal (either "advance" or "retard") originates in unit 4, it being applied to units 5 and 6 as well as unit 4 if the three-position switch is in the middle position which calls for feed forward correction. Similarly unit 5 provides a correction for unit 5 and unit 6 when a correction signal originates in unit 5, again assuming that the three-position switch is in its middle position.

It has already been mentioned that when the three-position switch is placed in its left hand switch position, the correction is applied only locally. This may be traced in a typical case for unit 2. A correction signal for "advance," originating in unit 2, comes from connector 100 through conductor 104, resistor 105, and rectifiers 106 to energize upper relay coil 108. This pulls the relay contacts in, and correction current then flows from the top relay contact through the first pole of the three-position switch to conductors 230, 232, cable 126, and conductor 234 to connector 102. This provides an "advance" correction for local unit 2. Thus with the three-position switch in its left hand switch position, the correction originating in unit 2 is effectuated only in unit 2.

Similar description applies to a "retard" instead of "advance" correction, this initiating a current flow from connector 100 through conductor 130 to resistor 132, rectifier 134 and "retard" relay coil 136. When the relay contacts are pulled in, the topmost contact supplies correction current through the left hand switch position to lines 238, 240, cable 126, and conductor 242 to connector 102, from which the "retard" correction current goes to the correction motor of unit 2.

It will be noted that when any three-position switch is in its left hand switch position, only the top relay contact is effective, the additional relay contacts terminating in dead end switch positions, which is as it should be, because in this case the correction is to be made only locally, and is not to go on to either preceding or succeeding color units. When the three-position switch is in its right hand switch position, again only the top relay contact is effective, because in this case feed back is to be provided, and the feed back is to only the immediately preceding unit, and therefore the other relay contacts lead to switch positions which are dead ended. However, when the three-position switch is in the middle switch position, calling for feed forward, the relay contacts shown in the diagram are all utilized in order to supply correction to the local unit and also all succeeding units. (In practise the relays may be alike, and therefore the later relays have excess contacts which simply are not utilized, and they have been omitted in the wiring

diagram for simplicity. Similar remark applies to the three-position switches, which in practice all may be ten-pole switches, with some of the poles of the later switches not utilized. Such extra switch poles have been omitted in FIG. 6.)

In all cases each unit has an "advance" relay and a "retard" relay, the coils of which are shunted by filter condensers. When a D.C. circuit is being used, the rectifiers and filter condensers are not needed.

The resistance-condenser combinations shown at 250 beneath connector 102 are simply spark suppressor circuits connected in shunt across the relay contacts.

With this switch arrangement it will be understood that feed forward may be provided without feed back, and in such case unit 2 is corrected locally, and a simultaneous feed forward correction is applied to all of the succeeding units, that is, to units 3, 4, 5 and 6. For this purpose it is merely necessary to put the three-position switch of unit 2 in its middle switch position.

The provision of the left hand switch position makes it possible to use a feed forward correction for a limited number of units. For example, one may begin with unit 4 and provide feed forward to units 5 and 6, while providing only localized correction for units 2 and 3. One may provide a feed back correction at unit 3, and feed forward beginning with unit 4. All switches could be put in the left hand switch position, in which case the feed back and feed forward both would be eliminated, and all corrections would be local, this being desired at times for comparison or research purposes.

We find that the best results are obtained by utilizing feed back from unit 2 to unit 1, and feed forward from unit 3 onward. In making this statement it should be kept in mind that numerous equivalent combinations may be made when less than all of the color units are required, so that with four colors, for example, the above numerals would apply if units 5 and 6 were being eliminated, but would not apply if units 1 and 2 were being eliminated, or 1 and 6. The present circuitry permits this flexibility of control, and in the last case, for example, with units 1 and 6 eliminated, the switch of unit 3 would be put in the right hand switch position, for feed back to unit 2, and the switch of unit 4 would be put in the middle switch position. The switch of unit 5 would be put in the left position for local correction.

It will be also be understood that the invention is in no way restricted to six-color units, and we have extended this system to an eight-color press, the essential difference then being merely the use of relays and three-position switches having more contacts and poles than here shown.

It should be noted that with feed forward the relays insulate a correction initiated in any unit against traveling back to a preceding unit. If the relays were not employed, and if simple direct wire connections were used, say from unit 3 to units 4, 5, and 6, the difficulty would arise that any correction arising in unit 4 or 5 would travel not only forward to a succeeding unit, but simultaneously backward to preceding units, which would be undesirable because it would destroy even a correct register existing in preceding units. The entire system would be put into a highly unstable and virtually inoperative condition. However, with the relay arrangement here shown, the feed forward correction is restricted to the forward direction, which is the direction of web movement and the direction in which the same correction should be applied for reasons explained above.

In FIG. 1 electric eyes 52, 53, etc. for the color units are shown located at the web input to the press. However they all may be located at the web output, as shown, for example, by the alternative eye 50 on color unit 2 in FIG. 1. In either case the mark which is scanned is that put down in color unit 1, and comparison is made with the micrometer signal from the phase micrometer secured to gravure cylinder 26. For that reason the elec-

tric eye may be mounted anywhere on the color unit, and there are different advantages for different locations.

Moreover the system may operate with one, or two, or more marks. When a single mark is used it is put down in color unit 1, and thereafter is scanned by all of the successive electric eyes. However, we prefer to put down a second mark in color unit 2, and the latter is scanned by the succeeding scanners 53, 54, 55 and 56. The first mark is scanned by the eye in the second color unit. The two marks are so located that the first mark does not affect the scanners intended to read the second mark.

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

We claim:

1. In the operation of a multi-color printing press having a series of color units, each with registration correction gearing including a remotely controllable reversible correction motor for introducing an advance or retard correction at the color unit, and means including an electric eye scanner and circuitry for detecting an error in registration and for controlling a correction motor, the method which includes scanning the web at the second color unit to detect any error in registration, and using such error to operate a correction motor at the first instead of at the second color unit.

2. In the operation of a multi-color printing press having a series of color units, each with registration correction gearing and including a remotely controllable reversible correction motor for introducing an advance or retard correction at any one of the color units, and means including an electric eye scanner and circuitry for detecting an error in registration and for controlling a correction motor, the method which includes scanning the web at the third color unit to detect any error in registration at that unit, using such error to simultaneously operate the correction motor at the third, fourth, fifth and succeeding color units, but not at the preceding first and second color units, scanning the web at the fourth color unit to detect any error in registration at that unit, using such error to simultaneously operate the correction motor at the fourth, fifth and succeeding color units, but not at the preceding first, second, and third color units, and so on with scanning at the fifth and any succeeding color units.

3. In the operation of a multi-color printing press having a series of color units, each with registration correction gearing including a remotely controllable reversible correction motor for introducing an advance or retard correction at the color unit, and means including an electric eye scanner and circuitry for detecting an error in registration and for controlling a correction motor, the method which includes scanning the web at the second color unit to detect any error in registration at that unit, using such error to operate a correction motor at the first but not at the second color unit, scanning the web at the third color unit to detect any error in registration at that unit, and using such error to simultaneously operate the correction motor at the third, fourth and succeeding color units, but not at the first and second color units.

4. In the operation of a multi-color printing press having a series of color units, each with registration correction gearing including a remotely controllable reversible correction motor for introducing an advance or retard correction at the color unit, and means including an electric eye scanner and circuitry for detecting an error in registration and for controlling a correction motor, the method which includes scanning the web at the second

color unit to detect any error in registration at that unit, using such error to operate a correction motor at the first but not at the second color unit, scanning the web at the third color unit to detect any error in registration at that unit, using such error to simultaneously operate the correction motor at the third, fourth, fifth and succeeding color units, but not at the first and second color units, scanning the web at the fourth color unit to detect any error in registration at that unit, using such error to simultaneously operate the correction motor at the fourth, fifth, and succeeding color units, but not at the first, second and third color unit, and so on with scanning at the fifth and any other succeeding color units.

5. A multi-color printing press comprising two or more color units, the first of said color units having registration correction gearing including a remotely controllable reversible correction motor for introducing an advance or retard correction at the first color unit, the second of said color units having an electric eye scanner and computer circuitry for detecting an error in registration, and circuitry between said computer of the second unit and the correction motor of the first unit whereby an error in registration causes the computer of the second unit to operate the correction motor of the first unit.

6. A multi-color printing press comprising a series of six or more color units, each of said color units having registration correction gearing including a remotely controllable reversible correction motor for introducing an advance or retard correction, said third and succeeding color units each having an electric eye scanner and computer circuitry for detecting an error in registration, circuitry from the computer of the third color unit whereby an error in registration at the third color unit simultaneously operates the correction motors at the third, fourth, fifth, and succeeding color units, additional circuitry from the computer at the fourth color unit whereby an error in registration at the fourth color unit simultaneously operates the correction motors at the fourth, fifth, and succeeding color units, similar type circuitry for the fifth and succeeding color units, and so on when there are more than six color units.

7. A multi-color printing press comprising a series of four or more other color units, each of said color units having registration correction gearing including a remotely controllable reversible correction motor for introducing an advance or retard correction, said color units except for the first color unit each having an electric eye scanner and computer circuitry for detecting an error in registration, circuitry between the computer of the second color unit and the correction motor of the first color unit whereby an error in registration at the second color unit operates the correction motor at the first color unit, and circuitry from the computer of the third color unit whereby an error in registration at the third color unit simultaneously operates the correction motors at the third and fourth color units, and at succeeding color units when there are more than four color units.

8. A multi-color printing press comprising a series of six or more color units, each of said color units having registration correction gearing including a remotely controllable reversible correction motor for introducing an advance or retard correction, said color units except for the first color unit having an electric eye scanner and computer circuitry for detecting an error in registration, circuitry between the computer of the second color unit and the correction motor of the first color unit whereby an error in registration at the second color unit operates the correction motor at the first color unit, circuitry from the computer of the third color unit whereby an error in registration at the third color unit simultaneously operates the correction motors at the third, fourth, fifth, and succeeding color units, additional circuitry from the computer at the fourth color unit whereby an error in registration at the fourth color unit simultaneously operates the correction motors at the fourth, fifth, and succeeding color units,

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similar type circuitry for the fifth and succeeding color units, and so on when there are more than six color units.

9. A multi-color printing press comprising a series of color units, each of said color units having registration correction gearing including a remotely controllable reversible correction motor for introducing an advance or retard correction, said color units except the first having an electric eye scanner and computer circuitry for detecting an error in registration, multiple correction circuitry between the computers and the correction motors, said multiple correction circuitry including for each unit, except the first and last units, two multiple pole relays, one relay being responsive to an "advance" signal and the other to a "retard" signal from the computer of its corresponding color unit, and wiring from the relay contacts to the correction motors of the corresponding unit and succeeding units, whereby a registration error at any unit feeds an appropriate correction to the correction motor of that unit and succeeding units.

10. A multi-color printing press comprising a series of color units, each of said color units having registration correction gearing including a remotely controllable reversible correction motor for introducing an advance or retard correction, said color units except the first having an electric eye scanner and computer circuitry for detecting an error in registration, multiple correction circuitry between the computers and the correction motors, said multiple correction circuitry including for each unit, except the first and last units, a multiple-pole multiple-position switch, and two multiple-pole relays, one relay being responsive to an "advance" signal and the other to a "retard" signal from the computer of its corresponding color unit, the poles of the "advance" relay being connected to half the poles of the switch, and the poles of the "retard" relay being connected to the other poles of the switch, and wiring from the stationary contacts of the switches to the correction motors, one switch position providing a feed-forward correction whereby a registration error at any unit feeds an appropriate correction to the correction motor of that unit and succeeding units, and another switch position providing a feed-back correction whereby a registration error at a particular unit operates the correction motor of the immediately preceding unit.

11. A multi-color printing press comprising a series of color units, each of said color units having registration correction gearing including a remotely controllable reversible correction motor for introducing an advance or retard correction, said color units except the first having an electric eye scanner and computer circuitry for detecting an error in registration, multiple correction circuitry between the computers and the correction motors, said multiple correction circuitry including for each unit, except the first and last units, a multiple-pole three-position switch, and two multiple-pole relays, one relay being responsive to an "advance" signal and the other to a "retard" signal from the computer of its corresponding color

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unit, the poles of the "advance" relay being connected to half the poles of the switch, and the poles of the "retard" relay being connected to the other poles of the switch, and wiring from the stationary contacts of the switches to the correction motors, one of the three switch positions providing a feed-forward correction whereby a registration error at any unit feeds an appropriate correction to the correction motor of that unit and succeeding units, another switch position providing a feed-back correction whereby a registration error at a particular unit operates the correction motor of the immediately preceding unit, and the third switch position providing a conventional localized correction whereby a registration error at a unit operates the correction motor of that same unit.

12. In the operation of a multi-color printing press having a series of color units, each with registration correction gearing and each including a remotely controllable reversible correction motor for introducing an advance or retard correction at any one of the color units, and all color units but one each having means including an electric eye scanner and circuitry for detecting an error in registration and for controlling a correction motor, the method which includes scanning the web at each of a plurality of color units to detect any error in registration, and using such error at each of said color units to simultaneously operate the correction motor at the said color unit and also at all succeeding color units, but not at the preceding color units, whereby the corrections actually made at the later color units are in each case the algebraic summation of the corrections indicated to be made at the preceding color units.

13. A multi-color printing press comprising a series of color units, each of said color units having registration correction gearing and each including a remotely controllable reversible correction motor for introducing an advance or retard correction at said unit independently of the other units, all of said color units but one each having an electric eye scanner and computer circuitry for detecting an error in registration, and electrical circuitry leading from the computer to the correction motor at the color unit having the scanner and also extending from the computer to the correction motors at the succeeding color units, whereby an error in registration at one of the color units causes the scanner at that color unit to simultaneously operate the correction motor at that color unit and also the correction motors at all of the succeeding color units, but not the correction motors at the preceding color units, whereby the corrections actually made at the later color units are in each case the algebraic summation of the corrections indicated to be made at the preceding color units.

References Cited in the file of this patent

UNITED STATES PATENTS

2,963,965 Baumgartner _____ Dec. 13, 1960