Feb. 21, 1961 G. N. AUERBACHER 2,972,297

MULTICOLOR PRINTING ON A CONTINUOUS WEB

Filed Oct. 3, 1957

Fig. 1

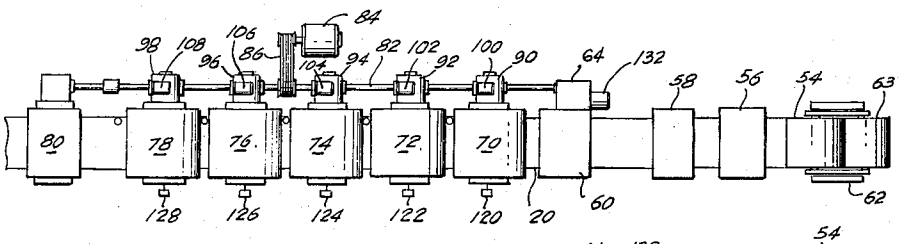


Fig. 2

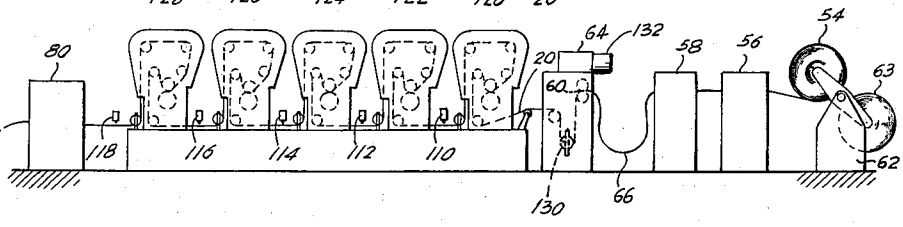


Fig. 3

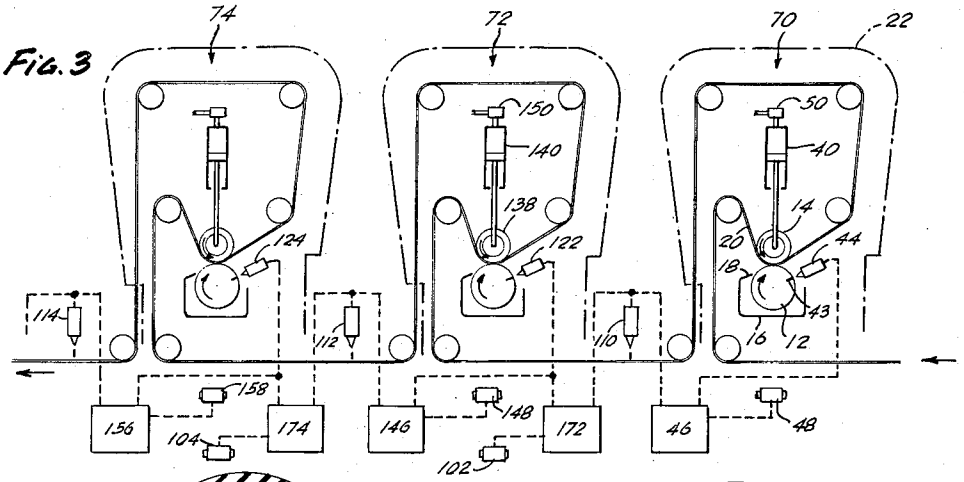


Fig. 4

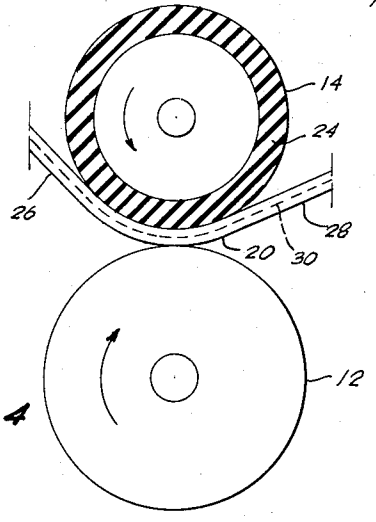
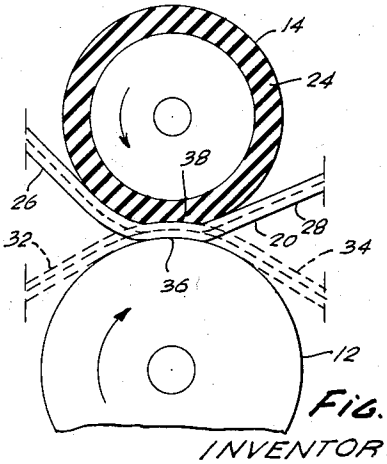


Fig. 5



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MULTICOLOR PRINTING ON A CONTINUOUS WEB

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10 Claims. (Cl. 101—181)

This invention relates to multicolor printing on a continuous web, and more particularly to the maintenance of registration of printed matter on a web which is comparatively thick.

The primary object of the present invention is to generally improve apparatus for performing multiple operations on a continuous web, which operations are required to be in registration. The most important example is multicolor printing, requiring a so-called print-to-print register. To maintain registration, running registers have been provided between a common drive shaft and the individual units of the press line driven by said shaft. Thus, additional motion or velocity may be added or subtracted at any unit to keep it in proper registration. To do this at high web speeds, photoelectric scanners have been devised which are located between units, and which automatically feed positive or negative motion at the running register, as may be required to maintain registration. Other expedients for this purpose are employed, such as movable compensator rollers which slightly lengthen or shorten the web between one press and the next.

In a multicolor press, the printing cylinders theoretically all have the same diameter, and it has been assumed that in such case the unit of printing matter or so-called "layoff" would be constant, and that departure from registration arises from variables such as web stretch or yield; minute changes in the web drive velocity at the printing cylinder; minute differences in cylinder diameter, etc. I have found that the difficulty may arise from minute differences in the length of printed matter or layoff which may occur even at a single printing cylinder of unquestioned constant diameter. An object of the present invention is to overcome such differences, and maintain uniform layoff of the printed matter on a web, particularly when dealing with a comparatively thick web.

This helps maintain registration, and the object of the invention may be defined more broadly as being to maintain registration of multicolor printing. In theory, one might eliminate running registers, but inasmuch as the uniform layoff of my invention presupposes perfect initial registration, and inasmuch as running registers are anyway convenient, and almost a necessity to secure initial registration, my invention in preferred form is used along with running registers, and serves to minimize the work which must be done by the running registers.

Web scanners are employed to detect any departure from uniform layoff, and in accordance with a further feature and object of my invention, the same web scanners may be employed for both purposes, that is, to help restore uniform layoff in the event of a departure from uniform layoff, and to help restore registration in the event of a departure from registration.

To accomplish the foregoing general objects, and other more specific objects which will hereinafter appear, my 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 a drawing in which:

Fig. 1 is a plan view of a multicolor printing press embodying features of my invention;

Fig. 2 is an elevation of the same;

Fig. 3 is a schematic elevation of a part of the press shown in Fig. 2, drawn to enlarged scale; and

Figs. 4 and 5 are companion fragmentary views explanatory of the underlying principle of the invention.

Referring to the drawing, and more particularly to Fig. 3, the right hand unit of the printing press there shown is of the intaglio or rotogravure type. It comprises an engraved printing cylinder **12**, and a cooperating impression cylinder **14**. Cylinder **12** is inked in any desired fashion, as by use of an ink fountain **16**, and the excess ink is scraped from the cylinder by a suitable doctor blade, schematically represented at **18**. The web **20** is passed between the cylinders **12** and **14**, and the underside thereof receives ink from the engraved impressions in the cylinder. The web is then dried by passing the same through a suitable drier, indicated at **22**, following which it is led to the next printing unit.

Referring now to Fig. 4 of the drawing, the printing cylinder **12** may be assumed to be conventional in that it is made of a non-yielding material, specifically metal, which is chemically etched to form the intaglio impressions therein. The impression cylinder **14** also is conventional, in at least to the extent that it is made of a yieldable material, typically rubber or its equivalent, as shown at **24**. The web **20** is shown approaching the cylinder **12** in a downwardly sloping direction at **26**, and leaving the cylinder **12** in an upwardly sloping direction at **28**. In other words, in Fig. 4 the web **20** is wrapped partially around the impression cylinder **14**, and it is convex in relation to the printing cylinder **12**. If the web has significant thickness, the upper surface is contracted, and the lower is stretched, relative to the mean or pitch length of the web indicated by the broken line **30**.

The printing cylinder **12** applies printed matter to the underside or stretched surface of web **20**, and on reflection it will become evident that when the web is subsequently straightened or laid flat, the printed matter will be slightly contracted. The layoff on the web then will be slightly less than the circumference of the printing cylinder **12**.

Referring now to Fig. 5, assumes that the web is wrapped partially around the printing cylinder **12**, as shown in broken lines, that is, it approaches the cylinder in upwardly sloping direction as shown at **32**, and leaves the cylinder in downwardly sloping direction, as shown at **34**. Differently expressed, the web is concave in respect to the printing cylinder **12**. Here again, one face of the web is stretched, and the other contracted, relative to the pitch line, but in opposite sense from what is shown in Fig. 4. Thus, when the web is subsequently straightened or laid flat, the printed matter on the bottom face of the web will be stretched or lengthened slightly, and the layoff will be slightly greater than the circumference of the printing cylinder.

Now, in practical apparatus of types already in common use, including the type illustrated in Figs. 1–3, it would not be convenient to keep changing the angle of approach and departure of the web from the printing cylinder. However, I have found that for purposes of the present invention, this may be done in effect, by changing the pressure exerted on the web by the impression cylinder. This is so because of its yieldable nature, and referring to Fig. 5 of the drawing, the web **20** shown in solid lines approaches and leaves the printing cylinder **12** in downward and upward sloping directions, **26** and **28**, exactly as in the case of Fig. 4, but increased pressure between the cylinders has caused a surface contact instead of a line contact with the printing cylinder at **36**, resulting from compression or yield of the material of the impression cylinder at **38**. The portion of

the web immediately at the printing cylinder is concave rather than convex in respect to the printing cylinder, and this is so despite the slope of the web at 26 and 28.

Thus, a variation in pressure exerted on the impression cylinder is equivalent to a change in web direction, or in convexity versus concavity relative to the printing cylinder. This in turn causes a change in layoff of the printed matter on the web, and thus the pressure of the impression cylinder may be used to vary the length of the layoff in one direction or the other.

Reverting now to Fig. 3 of the drawing, the apparatus includes a pressure exerting means 40 to exert pressure on the web between the cylinders 12 and 14. It further comprises a detector means 110, 44, 46 to detect any departure from uniform layoff of the printed matter, and further comprises means 48 and 50 for varying the pressure exerted on the web by the means 40 in that direction which tends to restore uniform layoff.

Considering the invention in greater detail, and referring more particularly to Figs. 1 and 2, web 20 is unwound from a large reel 54, and then passed through appropriate units such as a splicer 56, decurler 58 and pull unit 60. The roll 54 may be mounted on a roll carrier 62 designed to facilitate changing from one roll as it expires to a new roll, shown at 63. The expired roll may then be removed and replaced by another full roll preparatory to expiration of the second roll, and so on.

The web feed or pull unit 60 is arranged for fine speed adjustment, as by a means of an infinitely variable drive 64. There is usually a slack loop 66 ahead of the feed unit 60. The web then goes to a series of units for multiple operations on the web. In the present case, a multicolor gravure press is shown, comprising printing units 70, 72, 74, 76 and 78. These are followed by a pull unit 80, which may be followed by still further units, not shown, for scoring, creasing, punching or/and cutting the web.

Referring to Fig. 1, the units of the press line, and both pull units, are all driven in unison by a common drive shaft 82 driven by a motor 84 through suitable belts 86. The gearing between the shaft 82 and the gravure cylinder shafts is shown at 90, 92, 94, 96, 98, respectively. This ordinarily includes running register mechanism of the differential gear type, so that additional motion may be fed in by means of remotely controlled reversible correction motors, indicated at 100, 102, 104, 106 and 108. Running register 90 and correction motor 100 on the first unit 70 are not essential, but may be used for convenience and uniformity. The differential gear running registers need not be described in detail, for they are well known in the art, and reference also may be made to U.S. Patent No. 2,163,035 issued to William F. Grupe on June 20, 1939, and entitled "Apparatus for Effecting Register of Multiple Operations."

To automatically control the registration correction motors, the web may be scanned by suitable scanners housing photoelectric cells or "eyes," indicated in Fig. 2 at 110, 112, 114 and 116. These form part of a registration control apparatus which may be of the type disclosed in U.S. Patent 2,348,862 granted to Morris Sorkin on May 16, 1944 and entitled "Registration Control Apparatus." In that apparatus, the position of a mark on the web is compared or related to the position of a mark on the print cylinder shaft, and for this purpose, each print cylinder shaft is provided with a so-called "phase detector" unit. These are indicated in Fig. 1 at 122, 124, 126 and 128. Such units (scanner and phase detector) are not needed for the first press unit 70, because the problem is to keep the subsequent units in registration with the first unit.

In lieu of comparing the position of a mark put down on the web by the first unit, with the position of a mark on the second cylinder, it may be compared with a second mark put down on the web by the second cylinder (which, of course, is an indication of the position of the second cylinder). Such a system is disclosed in U.S. Patent 2,151,570 granted March 21, 1939 to D. R. Shoults et al. and entitled "Control System." For purposes of the present invention, there is some difference between a system using scanners to compare two marks on the web, and a system comparing a single mark on the web with a phase detector. Either system will control a correction motor to add motion to the drive of a unit, and thus speeds it or slows it slightly in order to hold it in register.

Structurally, there would be a difference in the addition of another scanner following the last printing unit 78, this being indicated at 118 in Fig. 2. This added scanner 118 would replace the phase detector shown at 128 in Fig. 1. In passing, it may be mentioned that even with phase detectors, the web scanners may be located (though less desirably) following their respective phase detector, instead of preceding the same, in which case the scanners 112 through 118 would be used with the phase detectors 122–128. The disadvantage is that the comparison for registration and the resulting correction are made later, after an additional length of web corresponding to that used in one printing unit. In any event, the phase detector system is more convenient here, because a phase detector is needed on at least the first unit for layoff control.

Referring to Fig. 2, feed unit 60 is followed by a dancer roll 130. This is gieven a weight corresponding to double the desired web tension, or it may be made of excessive weight and then counterbalanced by springs or a weight arm, no shown. The dancer roll 130 is mounted for vertical movement, and may be provided with limit switches, not shown. The infinitely variable drive 64 is driven by shaft 82, but has a remotely controlled reversible adjusting motor 132, and the limit switches at dancer roll 130 are connected to motor 132. The feed velocity is increased when the dancer roll 130 rises, and is decreased when it falls, in order to keep the dancer roll suspended at an intermediate point where its weight determines the tension of the web. The element 132 may be hydraulic, in which case its valves are electrically controlled, with the same end result.

As so far described, the apparatus shown in Figs. 1 and 2 may be conventional. It has long been the practice and understanding of the industry that the pressure exerted on and by impression cylinders should be maintained constant. Contrary to this prior practice, I have found that the maintenance of registration is greatly aided by varying the pressure applied on the web by the impression cylinder in such direction as to maintain constant "layoff" of the printed matter on the web.

Referring to Fig. 3, a web scanner 110 is located between the printing press unit 70, and the succeeding press unit 72. The printed matter put on the web by cylinder 12 includes a marker or target, and this is repeated a number of times along the web until the web scanner 110 is reached. The position or timing of the target is related to the position or timing of the cylinder 12, by use of a so-called phase detector rotating with cylinder 12. This is schematically shown at 120 in Fig. 1, and in Fig. 3 is schematically represented by a target 43 on the cylinder cooperating with a photoelectric eye 44. The web scanner 110 is connected to apropriate circuitry housed at 46, and the eye 44 is also connected to the circuitry at 46. The arrangement may be exactly like that used for registraiton control, as disclosed in the aforesaid Sorkin Patent No. 2,348,862. The output of the circuitry at 46 may be used to control a remote reversible correction motor 48. This in turn is used to vary the adjustment of a pressure regulator 50, and thus to vary the pressure exerted by the impression cylinder 14.

It will be understood that in practice the hydraulic cylinder 40 may be made double acting instead of single

acting as shown, with appropriate values to afford lifting of the impression cylinder under manual control when desired. In some systems, the impression cylinder and its associated bearings etc. may be heavier than the desired pressure on the web, and in such case, the hydraulic cylinder **40** may be double acting in order to lessen the effective weight of the impression cylinder, instead of adding to it. Other ways to vary the pressure of cylinder **14** may be used, such as compression springs in lieu of the hydraulic cylinders, with a reversible correction motor, reduction gearing, and screws to raise or lower the stationary ends of the compression springs, and thereby vary the pressure exerted thereby.

Whatever mechanism is employed for the purpose is preferably duplicated in each of the printing units. Thus, the impression cylinder **138** is controlled by hydraulic cylinder **140** and pressure regulator **150**, the latter being adjusted by a correction motor **148** which in turn is controlled by a web scanner **112**, and a phase detector **122** operating jointly through circuitry housed at **146**. Similarly in press unit **74**, the impression cylinder is controlled by web scanner **114** and phase detector **124** connected to circuitry housed at **156** and controlling a remote correction motor **158**. Similar remark applies to press units **76** and **78** not shown in Fig. 3, but shown in Figs. 1 and 2.

Two separate scanners may be used between the first and second presses, one scanner for use with the phase detector **120** for layoff control, and one for use with the phase detector **122** for registration correction. However, inasmuch as a single scanner may be wired to both circuits or control panels, I here show one scanner at **110**, serving both purposes.

Referring to Fig. 3, the first web scanner **110** is connected not only to the circuitry housed at **46** to maintain uniform layoff, but also to conventional circuitry housed at **172** which controls a remote reversible correction motor **102**. This is the motor also shown in Fig. 1 associated with the running register differential gearing at **92** for feeding positive or negative motion to the printing cylinder of press **72**. For this purpose, the web scanner **110** makes its comparison with the phase detector **122** on the next press **72**. The phase detector may be of more elaborate construction, such as that shown in Sorkin Patent 2,348,862 previously referred to.

In similar fashion, the web scanner **112** cooperates with a preceding phase detector **122** and the circuitry **146** to control correction motor **148** for uniform layoff, and the web scanner **112** cooperates with the succeeding phase detector **124** and circuitry housed at **174** to control a correction motor **104** which takes care of registration. More specifically, the motor **104** corersponds to that shown in Fig. 1 on the running register **94** for the press **74**. Similar remark would apply to the remaining web scanners and phase detectors, nearly all of which serve a dual function both for uniform layoff and for registration.

It is believed that the construction and operation of my improved apparatus, as well as the advantages thereof, will be apparent from the foregoing detailed description. The usual running register mechanism may be retained, and is preferably automatically controlled by the usual electric eye scanners. These may be of the double marker type (Shoults Patent 2,151,571) or of the single marker and phase detector type (Sorkin 2,348,862). However, even when the double marker type is used, one phase detector is employed, this being mounted on the first press unit, and serving for purposes of uniform layoff in the first press, where there is no preceding marker which could serve in lieu of a target on the cylinder, for purposes of comparison.

In general, a register correction afforded by the running registers represents a temporary change in speed at any one unit, to effect a change in position at that unit, in order to achieve registration. The amount of correction thus required is minimized by maintaining uniform layoffs at all of the press units, and in accordance with my invention, this is done by appropriately varying the pressure exerted on the web by the impression cylinders in proper direction to maintain the desired uniform layoff.

It will be understood that while I have shown and described my improved apparatus in a preferred form, changes may be made in the structure shown, without departing from the scope of the invention, as sought to be defined in the following claims. In the claims, the terms "marker" or "target" are intended to include a selected part of the desired printed matter, as well as a marker used solely as a target. The reference to the web being "comparatively thick" means merely that the web is thick enough to result in a difference between the pitch length and the lengths of the inner and outer faces, which difference is sufficient to make possible a layoff correction by pressure control as here taught.

I claim:

1. In the operation of a multicolor printing press working on a continuous comparatively thick web, with each unit of said press having a printing cylinder made of conventional non-yieldable material, and an impression cylinder made of conventional yieldable material, said cylinders exerting an operating pressure on the web, the method of helping maintain uniform layoff and registration of the colors, which includes putting a marker on the web in a first printing unit, scanning the marker between said first and a second printing unit to measure the position of the marker after a number of repeats of the marker in order to detect a change in layoff, and varying the pressure exerted in said first printing unit on the web between the printing cylinder and the impression cylinder in that direction which helps eliminate a departure from the desired uniform layoff while maintaining a minimum pressure sufficient to prevent slippage between the printing cylinder and the web.

2. In the operation of a multicolor printing press working on a continuous comparatively thick web, with each unit of said press having a printing cylinder made of conventional non-yieldable material, and an impression cylinder made of conventional yieldable material, said cylinders exerting an operating pressure on the web, the method of helping maintain uniform layoff and registration of the colors, which includes putting a marker on the web in each printing unit, scanning the marker of each unit between that unit and the succeeding unit to measure the position of the marker after a number of repeats of the marker in order to detect a change in layoff in each said preceding unit, and varying the pressure exerted on the web between the printing cylinder and the impression cylinder of each said preceding unit in that direction which helps eliminate a departure from the desired uniform layoff in the said preceding unit while maintaining a minimum pressure sufficient to prevent slippage between the printing cylinder and the web.

3. A printing press for working on a continuous comparatively thick web, said press having a printing cylinder made of conventional non-yieldable material, an impression cylinder made of conventional yieldable material, pressure exerting means to exert an operating pressure on the web between the printing cylinder and the impression cylinder, said operating pressure being variable but sufficient to prevent slippage between the printing cylinder and the web, detector means to detect a departure from uniform layoff of the printed matter printed on the web by the printing cylinder, and means responsive to said detector means for varying the pressure exerted on the web by the aforesaid pressure exerting means in that direction which tends to restore uniform layoff.

4. A multicolor printing press for working on a continuous comparatively thick web, the units of said press each having a printing cylinder made of conventional

non-yieldable material, an impression cylinder made of conventional yieldable material, an operating pressure exerting means to exert pressure on the web between the printing cylinder and the impression cylinder, said operating pressure being variable but sufficient to prevent slippage between the printing cylinder and the web, detector means to detect a departure from uniform layoff of the printed matter printed on the web by the printing cylinder, and means responsive to said detector means for varying the pressure exerted on the web by the aforesaid pressure exerting means in that direction which tends to restore uniform layoff in order to help maintain registration of the colors.

5. A multiple printing press working on a continuous comparatively thick web, each unit of said press having a printing cylinder made of conventional non-yieldable material, an impression cylinder made of conventional yieldable material, means to exert an operating pressure on the web between each printing cylinder and its cooperating impression cylinder, said operating pressure being variable but sufficient to prevent slippage between the printing cylinder and the web, web scanning means between a first unit and its succeeding unit arranged to detect any change in layoff of the printed matter produced in said first unit, and means responsive to said web scanning means for varying the pressure exerted on the web in said first unit in that direction which helps restore the desired uniform layoff in the said first unit.

6. A multiple printing press working on a continuous comparatively thick web, each unit of said press having a printing cylinder made of conventional non-yieldable material, an impression cylinder made of conventional yieldable material, means to exert an operating pressure on the web between each printing cylinder and its cooperating impression cylinder, web scanning means between a first unit and its succeeding unit arranged to detect any change in layoff of the printed matter produced in said first unit, means responsive to said web scanning means for varying the pressure exerted on the web in said first unit in that direction which helps restore the desired uniform layoff in the said first unit, a common drive shaft for said units, running register means between said drive shaft and the printing cylinder of the second unit, and means responsive to the aforesaid scanning means to supply positive and negative motion at said running register in that direction which helps restore registration of the matter printed by the different units of the press.

7. A multiple printing press working on a continuous comparatively thick web, each unit of said press having a printing cylinder made of conventional non-yieldable material, an impression cylinder made of conventional yieldable material, means to exert an operating pressure on the web between each printing cylinder and its cooperating impression cylinder, said operating pressure being variable but sufficient to prevent slippage between the printing cylinder and the web, web scanning means between each unit and its succeeding unit arranged to detect any change in layoff of the printed matter produced in each said preceding unit, and means responsive to each web scanning means for varying the pressure exerted on the web in each said preceding unit in that direction which helps restore the desired uniform layoff in the said preceding unit.

8. A multiple printing press working on a continuous comparatively thick web, each unit of said press having a printed cylinder made of conventional non-yieldable material, an impression cylinder made of conventional yieldable material, means to exert an operating pressure

on the web between each printing cylinder and its cooperating impression cylinder, web scanning means between each unit and its succeeding unit arranged to detect any change in layoff of the printed matter produced in each said preceding unit, and means responsive to each web scanning means for varying the pressure exerted on the web in each said preceding unit in that direction which helps restore the desired uniform layoff in the said preceding unit, a common drive shaft for said units, running register means between said drive shaft and the printing cylinder of the second and succeeding units, and means responsive to said web scanning means to supply positive or negative motion at said running registers as needed to help restore registration in the event of departure from registration of the matter printed by the different units of the press.

9. A multiple printing press working on a continuous comparatively thick web, each unit of said press having a printing cylinder made of conventional non-yieldable material, an impression cylinder made of conventional yieldable material, means to exert an operating pressure on the web between each printing cylinder and its cooperating impression cylinder, said opearting pressure being variable but sufficient to prevent slippage between the printing cylinder and the web, web scanning means between a first unit and its succeeding unit arranged to detect any change in layoff of the printed matter produced in said first unit, means responsive to said web scanning means for varying the pressure exerted on the web in said first unit in that direction which helps restore the desired uniform layoff in the said first unit, a common drive shaft for said units, running register means between said drive shaft and the printing cylinder of the second unit, and means responsive to the aforesaid web scanning means to supply positive and negative motion at said running register in that direction which helps restore registration of the matter printed by the different units of the press.

10. A multiple printing press working on a continuous comparatively thick web, each unit of said press having a printing cylinder made of conventional non-yieldable material, an impression cylinder made of conventional yieldable material, means to exert an operating pressure on the web between each printing cylinder and its cooperating impression cylinder, said operating pressure being variable but sufficient to prevent slippage between the printing cylinder and the web, web scanning means between each unit and its succeeding unit arranged to detect any change in layoff of the printed matter produced in each said preceding unit, and means responsive to each web scanning means for varying the pressure exerted on the web in each said preceding unit in that direction which helps restore the desired uniform layoff in the said preceding unit, a common drive shaft for said units, running register means between said drive shaft and the printing cylinder of the second and succeeding units, and means responsive to the aforesaid web scanning means to supply positive or negative motion at said running registers as needed to help restore registration in the event of departure from registration of the matter printed by the different units of the press.

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