March 17, 1964 R. REINARTZ ETAL 3,125,022

REGISTERING ADJUSTMENT FOR MULTI-COLOR PRINTING

Filed April 3, 1962 2 Sheets-Sheet 1

FIG.1.

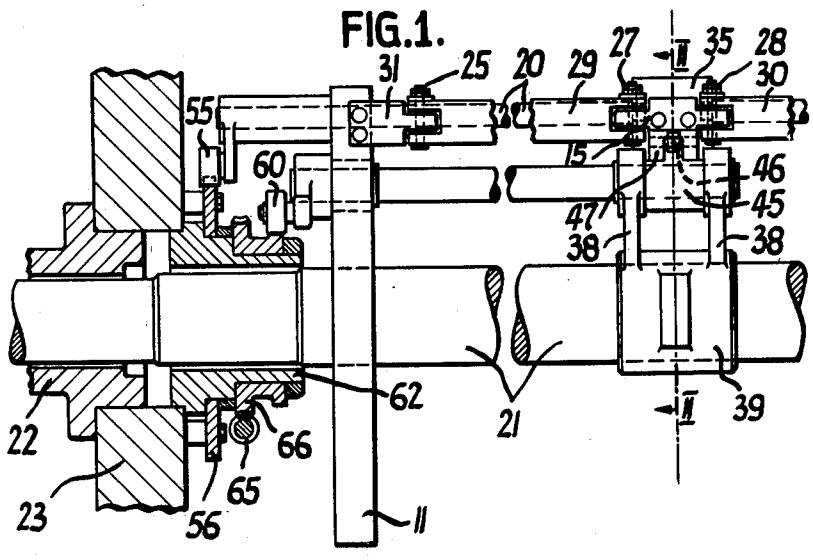
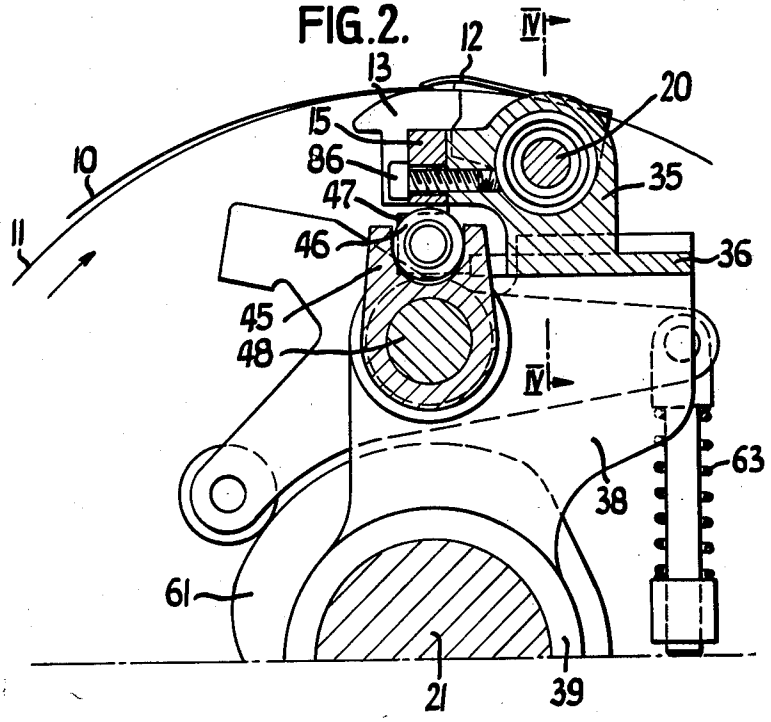


FIG.2.



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Filed April 3, 1962 2 Sheets-Sheet 2

FIG.3.

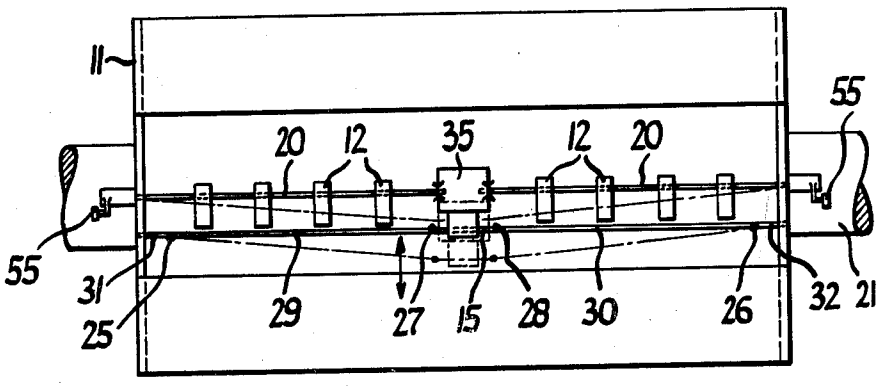


FIG.5

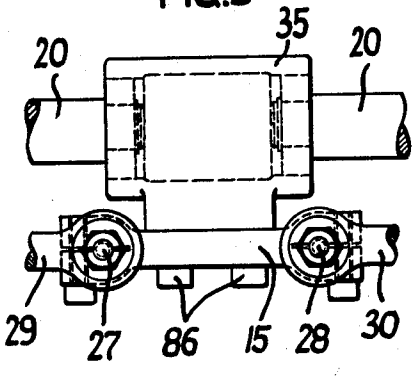
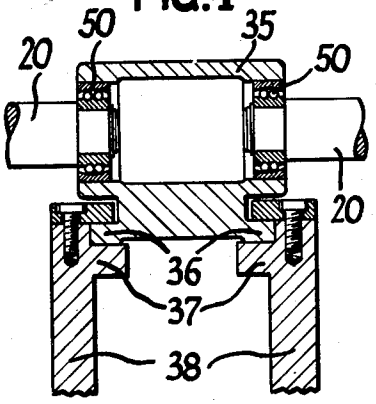


FIG.4



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REGISTERING ADJUSTMENT FOR MULTI-COLOR PRINTING

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10 Claims. (Cl. 101—183)

This invention relates to multi-color printing on sheet-fed multi-color printing presses and, more particularly, to an arrangement having adjustably displaceable sheet gripper mechanisms for selectively and controllably distorting sheets of paper being printed to compensate for opposite distortions of the sheets during printing which may adversely affect proper registration of the successive images printed on each sheet to achieve the multi-color printed impression.

In multi-color printing where a final composite multi-color image is formed by the successive printing impressions of a plurality of superimposed single color images, the fine quality of the finished effect depends to a large extent upon the precision and accuracy with which the several successively printed individual impressions or images are registered or congruent to form the composite multi-colored image. With sheet-fed multi-color presses and especially those having a large number of separate successive printing units, however, dimensional variations in the paper sheets being printed may occur during the printing run, as caused by changes in moisture content of the paper (especially with lithographic printing) or other factors. Thus, regardless of the care with which the various printing plates are positioned at the various printing stations to contact the sheets of paper over precisely the same area to provide exact registration of the several superimposed images or impressions, dimensional variations or distortions of the paper sheet, such as may be caused by swelling of the cellulose fibers with variations in moisture content, may cause distortions of the registration of the several superimposed impressions during the actual printing thereof.

If it is attempted to correct or compensate for such dimensional variations in the sheets of paper or other material to be printed as by distorting the sheet at the sheet feeding mechanism before the first printing unit, satisfactory or complete compensation may not be achieved throughout the passage of the sheet through all the subsequent printing units. For example, some compensatory control may be achieved for the first printing unit by providing a control flap or lever for bowing the center of the sheet at the original sheet feeder, or by otherwise arranging for the sheet to be non-uniformly introduced into the first printing unit, but even if satisfactory compensation is secured at the first unit, the normal slippages, etc., in the sheet gripping mechanisms of other units may preclude similar compensatory distortion of the sheet there.

Similarly, attempting to feed the sheets non-uniformly into sheet grippers arranged on a curve instead of in a straight line across the press and before the first printing unit may produce some compensatory deforming of the sheets, but only with relatively thin paper and not when heavier paper sheets are being used. Especially with a large number of sequential printing units in the multi-color press, moisture-induced distortions or dimensional variations may occur in the paper sheet to different extents and producing distortions in different directions as the sheet progresses through the press, so that various means of attempting to compensate for such distortions at the sheet feeding end of the press may not produce satisfactory or individually controllable results

as may be needed at each printing station or for complete and precise registration of each of the several individual printing impressions into the final composite multi-color image desired when the printing of the sheet is finished.

According to this invention, however, there is provided for deforming the leading edge of the sheets at or immediately before each printing station in multi-color printing presses, and in an individually adjustable manner, with such deformation being controllably provided in or opposite to the direction of sheet travel or transversely of the sheet, to stretch or warp or otherwise deform the sheet non-uniformly to a greater or less extent across the width thereof or otherwise as an aid in maintaining the impression area of the sheet in precise registration for the sequential printing impressions notwithstanding substantial dimensional variations in the sheet itself arising from changes in moisture content or otherwise. Such effects may be provided in accordance herewith as by arranging the rotating or reciprocating sheet gripping mechanism for each printing station so as to grip the leading edge of the sheets and displace the center of the leading edge of the sheet in a manner which deforms the sheet to compensate for the above difficulties as the sheet is led into each printing station; and, as a further feature of this invention, mechanism is provided whereby both the extent and direction of such distortion of the center of the leading edge of the sheet is individually controlled at each printing station as may be required to produce the particular compensation desired at that station in the registering of the sequentially printed images or impressions.

With the foregoing and additional objects in view, this invention will now be described in more detail, and other objects and advantages thereof will be apparent from the following description, the accompanying drawings, and the appended claims.

In the drawings:

FIG. 1 is a partial front elevation, with some parts broken away or removed, or part of the sheet gripper mechanism of a sheet-fed printing press having this invention applied thereto;

FIG. 2 is a partial vertical section along the line II—II of FIG. 1;

FIG. 3 is a simplified diagrammatic or schematic view indicating further aspects of the operation of the mechanism of FIG. 1;

FIG. 4 is a detailed sectional view of a portion of the mechanism of FIG. 2 and taken along the line IV—IV thereof; and

FIG. 5 is a partial top plan view on a somewhat larger scale of part of the mechanism of FIG. 1.

Referring to the drawings, in which like reference characters refer to like parts throughout the several views thereof, an arrangement of apparatus embodying and for practicing this invention is illustrated as being applied to the gripper mechanism in the impression cylinder for one printing station of a sheet-fed printing press, which mechanism is for gripping the leading edge of a sheet of paper or other material to be printed and carrying the sheet around the impression cylinder for printing contact with a printing plate bearing against the sheet around the impression cylinder during a portion of the rotation thereof. Since such gripping mechanism in rotating impression cylinders is well known and understood in this art, the drawings are primarily directed to illustrating the application of this invention to such otherwise well known or conventional printing press arrangements, and many of the constructional elements of the printing press and the impression cylinder have been omitted from the drawings for clarity and simplicity. It is also to be understood that this invention is applicable to swinging or

reciprocating sheet gripping mechanisms operating conventionally in association with the impression cylinder of a sheet-fed printing press, notwithstanding that the particular embodiment illustrated is shown as applied to sheet gripping mechanism within or on the impression cylinder.

Thus, a sheet of paper or other material to be printed is indicated at 10 as overlying the impression surface of a printing press impression cylinder 11 rotating in the direction of the arrow in FIG. 2, and with the leading edge of sheet 10 gripped by sheet gripping mechanism including movable gripping fingers 12 for gripping the edge of the sheet against stationary gripping supports 13 mounted along gripper support rail (15 in FIG. 2) extending axially across impression cylinder 11 between the opposite ends thereof, all in known manner. Also, as will be understood, the opening and closing of gripper fingers 12 with respect to gripper supports 13 are cyclically effected and controlled by rotation of gripper shaft 20 by the action of a cam arrangement (described below) timed with the rotation of the impression cylinder 11 for the gripping and release of the leading edge of successive sheets 10 during the printing operation.

As noted, since the illustrated embodiment relates to the sheet gripping mechanism mounted within a rotating impression cylinder, a main shaft 21, carrying cylinder 11 and its associated mechanism, is mounted for rotation across the printing press and as, for example, journaled at 22 in the opposite side walls or supports of the press 23, whereby cylinder 11 rotates during the press operation and sheets 10 to be printed are sequentially fed thereto to be gripped by grippers 12 and carried around the surface of cylinder 11 for impression against the printing plate at that particular printing station of the press.

In accordance herewith, the desired compensatory distortion of sheet 10 is achieved by adjustably and selectively displacing the grippers 12—13 at the central portion of the sheet, rather than having all the grippers arranged and maintained in a straight axial line along cylinder 11. Thus the gripper support rail 15 does not extend rigidly clear along cylinder 11, but is provided in a plurality of articulated or hinged segments (as indicated in FIG. 3 and described in more detail below). In the illustrated embodiment, gripper support rail 15 is hinged or pivoted adjacent opposite ends of cylinder 11 as indicated at 25 and 26, as well as being similarly hinged or articulated adjacent the center of the width of the printing press as indicated at 27 and 28, so that the gripper support rail clear across cylinder 11 is actually made up of a central rigid segment 15, to which are hinged articulated segments 29 and 30, each of which is in turn hinged, respectively at 25 and 26, to stationary gripper supporting rail segments 31 and 32 mounted at opposite ends of impression cylinder 11.

The central portion or segment 15 of the gripper support rail is mounted on carriage 35, as by bolts 86, and carriage 35 is in turn mounted for limited sliding movement along the line of travel of sheet 10 through the printing press, as by rails 36 slidably engaging supporting races 37 on radially extending supporting arms 38 of a bracket arrangement 39 mounted centrally of cylinder 11 and, in the illustrated embodiment, on main shaft 21 thereof.

The desired cyclical and adjustable sliding movement of carriage 35 on supporting arms 38 (from left to right in FIG. 2 and up and down in FIG. 3) is provided, in the illustrated embodiment, by a bifurcated swinging member 45 engaging a roller 46 mounted between depending projections 47 on carriage 35, and with bifurcated member 45 being mounted for rotation with a control shaft 48, the cyclic and controlled rotation thereof being effected, as described below, from mechanism at the end of cylinder 11. Thus, as apparent from the foregoing, the entire mechanism indicated in FIG. 2 is within and

rotates with cylinder 11. Yet, during such rotation, carriage 35 may be moved to the left or right in FIG. 2 and as rails 36 slide in races 37 on arms 38, according to the angular positioning of bifurcated element 45 on control shaft 48.

Such movement of carriage 35 to the right or left also moves central rigid segment 15 of the gripper support rail and, consequently, articulated segments 29 and 30 thereof pivoted to segment 15. Thus, depending upon the movement or positioning of carriage 35 to the left or the right in FIG. 2, the central portion of the leading edges of sheets 10 gripped by grippers 12—13 will be more or less distorted out of a straight line, as compared with the conventional situation where all the grippers 12—13 are rigidly aligned axially straight along impression cylinder 11 to hold the leading edge of sheet 10 uniformly along a straight line, instead of deforming the leading edge of the sheet to one extent or another as carriage 35 and grippers 12—13 moved thereby are misaligned to one extent or another with the stationary opposite end segments 31 and 32 of the gripper support rail.

In order to accommodate such movement or misalignment of the various stationary and articulated segments 31, 29, 15, 30, and 26 of the gripper support rail and to accomplish operation of gripper fingers 12 with respect thereto notwithstanding such misalignments, articulation of gripper shaft 20, the rotation of which controls operation of the grippers 12, is also provided in accordance herewith. That is, in the illustrated embodiment, gripper shaft 20 includes adjacent the center thereof and enclosed within carriage 35 self-aligning bearings indicated by 50, in known manner, to provide for rotation of gripper shaft 20 notwithstanding the misalignments therein depending upon the position of carriage 35.

The cyclic or intermittent rotation of gripper shaft 20, for the purpose of opening and closing grippers 12 against gripper supports 13 to engage and release the leading edge of sheets 10 as impression cylinder 11 rotates, is provided, in generally conventional manner, as by cam followers 55 engaging a cam surface 56 mounted beyond the ends of cylinder 11 and, for example, on side frames 23 of the printing press whereby, as well understood, gripper shaft 20 will be rotated in one direction or the other for opening and closing gripper fingers 12 at predetermined angular positions of impression cylinder 11. Because of the articulated character of gripper shaft 20 in the self-aligning bearings 50 in carriage 35, however, such cam and cam follower arrangements 55—56 are duplicated at both sides of the printing press and beyond both ends of impression cylinder 11.

The cyclic or controlling rotation of control shaft 48, providing for the positioning of carriage 35 to the left or right of FIG. 2 at the various angular positions of cylinder 11, is effected in the illustrated embodiment by cam follower 60 engaging cam surface 61 mounted on boss 62 in the side frame 23 of the printing press. A spring mechanism 63 is provided in known manner to urge cam follower 60 against cam surface 61. Preferably, in order to adjust and control both the extent and cyclic period of the movement of carriage 35, cam surface 61 is provided as an independently rotating element, driven by worm 65 meshing with worm gear teeth 66 to provide an infinitely variable drive or control (in known manner) whereby the rotation and angular positioning of cam surface 61 can be both predetermined and altered during and independent of rotation of cylinder 11 to adjust and control momentarily and individually for each different printing station the period and degree of displacement or misalignment of carriage 35 and the associated gripper fingers 12 and gripper supports 13 with respect to the axis of impression cylinder 11, as may be required from printing station to printing station because of the quality or heaviness of the paper sheets 10 being printed and/or the accumulated moisture-induced or other distortions thereof.

Operation of a printing press including the illustrated embodiment of this invention, and according to the foregoing, is further illustrated with reference to the schematic or diagrammatic showing of FIG. 3. Thus, in the normal or conventional type of arrangement, the several grippers 12 are axially aligned all along impression cylinder 11 across the printing press, and are controlled, under the action of a gripper shaft 20 and the cyclic or intermittent rotation thereof induced by cam followers 55 reacting to the particular profile of cam surface 56 during rotation of cylinder 11, to open and close and receive and release the leading edge of a sheet 10 introduced in known manner thereinto and to grip the sheet and carry it around the surface of impression cylinder 11 for a printing impression against the printing plate of the press. In accordance with this invention, by contrast, a selected and individually controlled or adjusted rotation of control shaft 48 displaces carriage 35 out of axial alignment and, as illustrative, into the dot-dash line position indicated in FIG. 3, whereby the grippers 12 nearest carriage 35 and in the area of the lateral central portion of the leading edge of sheet 10 may move through a longer path than those of the grippers 12 which are positioned more adjacent the ends of cylinder 11 and lateral edges of sheets 10.

That is, the leading edge of each sheet 10 is introduced to and gripped by all the grippers 12 with carriage 35 and the various segments 15, 29—30, and 31—32 of the gripper support rail in axially aligned position as indicated by the full lines in FIG. 3. Thereafter (as effected or predetermined by the particular profiling of cam surface 61 and the variable control drive 65—66 therefor) carriage 35 is moved more or less out of alignment in whatever direction may be desired so as to deform or stretch or bow the leading edge of sheet 10 in a manner and to an extent at least partially compensatory of whatever moisture-induced or other dimensional variation the sheet has undergone, so that the stretched or deformed sheet is presented around the surface of impression cylinder 11 and for a printing impression thereon in a manner to assure that the registration of that particular printing impression, with previous and subsequent sequential printing impressions, is achieved and received by sheet 10 in accurate registration to form the desired finished composite image and notwithstanding the deformations of the paper.

As will be apparent from the foregoing, perfect registration or any lack thereof is immediately observable during the press run with respect to the impression provided by each printing station on sheet 10. Therefore, with the foregoing arrangement, any necessary compensation can be provided, by regulation as may be required to provide the extra stretching or distortion, merely by regulating the infinitely variable drive 65—66 of cam surface 61. Actually, if no distortion or compensation therefor is required, the arrangement in accordance herewith readily functions the same as any conventional sheet gripping mechanism and with the grippers 12 and carriage 35 all axially aligned, as if they were rigidly supported, as in the full line position of FIG. 3. Yet, with but a simple adjustment at each printing station as and if and when required, carriage 35 is displaced in one way or the other so that the various grippers 12 stretch the sheet 10 from the center in one way or the other (after having all gripped it in aligned position) so that the sheet will be presented to receive its printed impression in precise register, and notwithstanding the fact that the difference in distortion necessary at each of the printing stations of the multi-color press may be different or that the dimensional variations during printing may vary from time to time for the same press run.

Thus there is provided in accordance herewith structures and arrangements (applicable either to sheet gripping mechanism built conventionally into impression cylinders of sheet-fed presses or to the reciprocating or chain-driven sheet grippers which feed sheets to such impression cylinders for individual printing stations) whereby a predetermined and constantly controlled and individually adjustable distortion may be readily induced to each sheet presented individually at each printing station to compensate for or otherwise correct or adjust dimensional variations within the sheet or other necessary perfections of the precise registering of that particular printed impression so that the printed image coincides exactly as desired with the previously or subsequently printed area of the sheet to obtain the desired final composite multi-color printed image on the sheet notwithstanding dimensional distortions or variations of the sheet occasioned by moisture changes or other factors to which it is subjected during the printing process. Similarly, there is provided in accordance with the foregoing for individual adjustment of such distortions or stretching or other control at each printing station and for accommodating the particular characteristics of each press run including variations in performance of different grades or weights of paper as well as variations between different printing stations on the same printing press, by distorting or stretching or otherwise compensating for the necessary changes at each printing station after the leading edge of the sheet to be printed has been firmly gripped, and by displacing the various grippers across the impression cylinder to stretch or deform the sheet to a greater or lesser extent with regard to both lateral and longitudinal dimensional changes therein and without interfering with either the speed or other factors of the normal operation of the printing press whether or not the dimensional changes being compensated for occur uniformly among all the printing stations and with various different types of sheet material being printed.

As apparent from the foregoing, the arrangements of apparatus provided in acordance herewith are readily and simply supplied, even within a rotating impression cylinder, and are similarly simply applicable, as will be understood, to reciprocating or chain-driven sheet gripping mechanism for feeding a particular printing station or otherwise for individually and adjustably and controllably distorting sheet material being fed to each individual printing station in a multi-color press to compensate for the aforementioned dimensional variations within the sheet which may affect the appropriate or optimumly desired precise registration of a plurality of superimposed printed impressions forming a composite multi-colored finished result.

While the arrangements of structures and apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise structures and apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. In a sheet-fed multi-color printing press having a plurality of printing stations for sequential printing of superimposed images on congruent areas of sheets fed through all said stations and having an impression cylinger at each said printing station for receiving said sheets to be printed and for impression thereof against a printing plate at each said station and in which said sheets are susceptible to dimensional variations and deformations during said printing of said sequential images thereon, the combination which comprises a plurality of sheet gripping means on said impression cylinder gripping the axially extending leading edge of each said sheet fed thereto, and including a plurality of said grippers spaced axially along said cylinder and normally axially aligned with respect thereto, an articulated rail along said cylinder with portions thereof independently movable circumferentially thereof, means for mounting said sheet grippers along said articulated rail, means for displacing selected portions of said articulated rail and said grippers

mounted thereon into and out of axial alignment with said cylinder for distorting said leading edge of said sheets effecting concomitant distorting of the area of said sheets to be printed for compensating for said dimensional variations and deformations thereof, said distortion of said sheets being positively maintained throughout substantially the entire passage of each said sheet through each said printing station, and means for adjusting the extent and direction of said selective displacement of said articulated rail and said grippers thereon for controlling the distortion of said sheets to compensate for said dimensional variations and deformations thereof during said printing at each said printing station.

2. Apparatus as recited in claim 1 in which said means for moving said articulated rail includes a central carriage, means for mounting said carriage in said impression cylinder for limited circumferential movement with respect to the surface thereof, and means in said cylinder for moving said carriage to any of a plurality of different circumferential positions during continued rotation of said impression cylinder about the axis thereof.

3. Apparatus as recited in claim 2 in which said means for moving said carriage includes variable speed drive means for controlling and adjusting said movement of said carriage cyclically during rotation of said impression cylinder.

4. Apparatus as recited in claim 1 which also includes a gripper shaft extending along said cylinder for cyclically actuating all said grippers to grip said sheets and means for driving said shaft during rotation of said impression cylinder about the axis thereof, said shaft being axially articulated for displacement into and out of axial alignment along said cylinder along with said articulated rail.

5. Apparatus as recited in claim 2 which also includes articulated gripper shaft segments for actuating said grippers to grip said sheets, means beyond the end of said cylinder for driving said gripper shaft segments, and bearing means on said carriage for rotatably supporting centrally located ends of said gripper shaft segments in both axially aligned and misaligned positions thereof.

6. In a sheet-fed multi-color printing press having a plurality of printing stations for sequential printing of superimposed images on congruent areas of sheets fed through all said stations and having an impression cylinder at each said printing station for receiving said sheets to be printed and for impression thereof against a printing plate at each said station and in which said sheets are susceptible to dimensional variations and deformations during said printing of said sequential images thereon, the combination which comprises a plurality of sheet gripping means on said impression cylinder gripping the axially extending leading edge of each said sheet fed thereto, and including a plurality of said grippers spaced axially along said cylinder and normally axially aligned with respect thereto, an articulated rail along said cylinder with portions thereof independently movable circumferentially thereof, means for mounting said sheet grippers along said articulated rail, means for displacing selected portions of said articulated rail and said grippers mounted thereon into and out of axial alignment with said cylinder for distorting said leading edge of said sheets effecting concomitant distorting of the area of said sheets to be printed for compensating for said dimentional variations and deformations thereof, said distortion of said sheets being positively maintained throughout substantially the entire passage of each said sheet through each said printing station, means for adjusting the extent and direction of said selective displacement of said articulated rail and said grippers thereon for controlling the distortion of said sheets to compensate for said dimensional variations and deformations thereof during said printing at each said printing station, a gripper shaft extending along said cylinder for cyclically actuating all said grippers to grip said sheets, means for driving said gripper shaft during rotation of said cylinder, said gripper shaft being axially articulated to conform to circumferential movements of said articulated rail, and means for positively and circumferentially displacing said gripper shaft in accordance with said circumferential displacement of said articulated rail.

7. Apparatus as recited in claim 6 in which said means for moving said articulated rail and said articulated gripper shaft includes an axially central carriage, means for mounting said carriage in said impression cylinder for limited circumferential movement with respect to the surface thereof, and means in said cylinder for moving said carriage to any of a plurality of different circumferential positions during continued rotation of said imperssion cylinder about the axis thereof.

8. Apparatus as recited in claim 7 in which said means for moving said carriage incluudes variable speed drive means for controlling and adjusting said movement of said carriage cyclically during rotation of said impression cylinder.

9. Apparatus as recited in claim 1 in which said articulated rail includes a plurality of segments pivoted for displacement in circumferential directions about said cylinder and in which means for effecting said circumferential displacement are disposed in said cylinder intermediate the extreme ends thereof for selectively displacing at least some of said gripper means according to said distortions and dimensional variations experienced by said sheets passing through said printing stations.

10. Apparatus as recited in claim 9 in which generally centrally disposed ends of segments of said articulated rail are mounted in swingable bearing engagement with said means for effecting said circumferential displacement.

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