(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 422 979 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.02.2012 Bulletin 2012/09

(21) Application number: **10174576.8**

(22) Date of filing: **31.08.2010**

(51) Int Cl.:
B41F 5/18 *(2006.01)* ***B41F 5/24*** *(2006.01)*
B41F 13/18 *(2006.01)* ***B41F 33/00*** *(2006.01)*
B41F 33/02 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
BA ME RS

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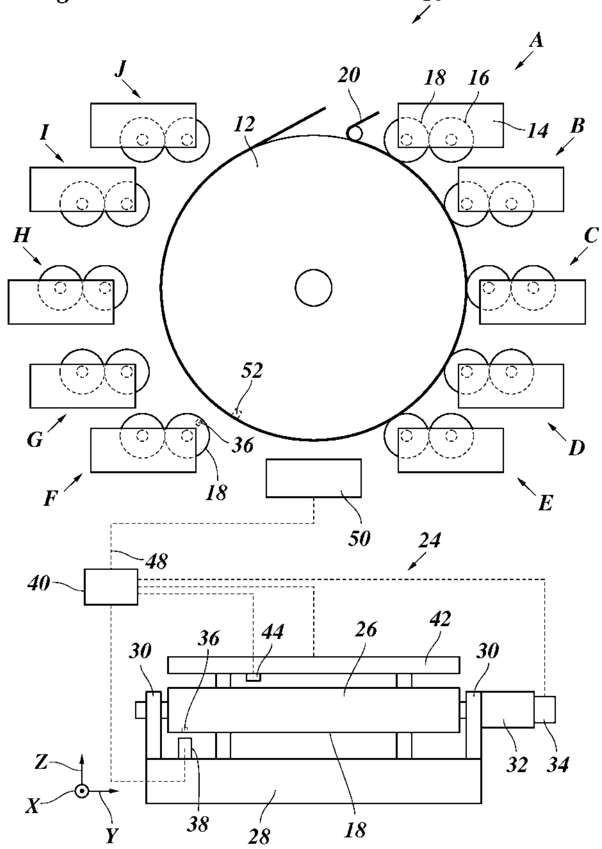
(54) **Rotary printing press with central impression cylinder**

(57) A rotary printing press comprising a central impression cylinder (12) and a plurality of colour decks (A-J) disposed at the periphery thereof, each colour deck including a printing cylinder (18) adapted to be set against the central impression cylinder (12) and having a reference mark (36) arranged in its peripheral surface, the printing press further including a detector (52) for detecting the reference mark (36), characterized in that the detector (52) is arranged in the peripheral surface of the central impression cylinder (12).

Fig. 1



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Description

[0001] The invention relates to a rotary printing press comprising a central impression cylinder and a plurality of colour decks disposed at the periphery thereof, each colour deck including a printing cylinder adapted to be set against the central impression cylinder and having a reference mark arranged in its peripheral surface, the printing press further including a detector for detecting the reference mark.

[0002] In a rotary printing press, e.g. a flexographic printing press, the position of the printing cylinder must be adjusted with high precision relative to other machine components, e.g. a central impression cylinder (CI), an anilox roller, the lateral frame of the machine (for adjusting the side register), and the like. In a typical flexographic printing press, a number of colour decks are arranged at the periphery of a CI, and each colour deck comprises a bearing structure for the printing cylinder and another bearing structure for the anilox roller. Each bearing structure comprises two bearing blocks that support the opposite ends of the printing cylinder and the anilox roller, respectively, and are movable relative to the machine frame in a predetermined direction (e.g. horizontal) so as to bring the peripheral surface of the printing cylinder into engagement with a print substrate (web) on the CI and to bring the peripheral surface of the anilox roller into engagement with the printing cylinder. The movements of the bearing blocks are controlled independently of one another by means of servo-motors which also permit to precisely monitor the positions of the bearing blocks. The exact positions which the bearing blocks have to assume during a print process depend among others upon the thickness of a printing sleeve and/or printing plates that are mounted on the printing cylinder.

[0003] When the printing press has to be prepared for a new print job, the printing cylinders have to be exchanged. In a known printing press, a hollow-cylindrical adapter which carries the printing plates or a printing sleeve is removably mounted, e.g. hydraulically clamped, on a mandrel that remains in the machine. In order to exchange the adapter, the bearing at one end of the mandrel is removed, so that the adapter can be withdrawn axially from the mandrel. Then, the new adapter, with the printing sleeve or plates carried thereon, is thrust onto the mandrel and is clamped thereon. Then, the bearing that had previously been removed is restored again.

[0004] In a start-up phase of the print process, the contact pressure between the printing cylinder and the CI and between the anilox roller and the printing cylinder has to be adjusted with high precision. Conventionally, this is done by first moving the printing cylinder and the anilox roller into predetermined start positions by appropriately controlling the servo-motors for the bearing blocks. Then, the print process is started, the print result is monitored, and a fine adjustment is performed for optimising the contact pressures. This so-called setting procedure takes a certain amount of time, and, since the quality of the printed images produced during this time will not be satisfactory, a considerable amount of waste is produced.

[0005] In WO 2008/049500 A2, a printing press according to the preamble of claim 1 and an automated setting procedure have been proposed which aim at reducing or eliminating this waste. According to this proposal, the geometry of the printing cylinder is precisely measured beforehand, for example while the printing cylinder is supported in a mounter which is used for mounting the printing plates thereon. The geometry data of the printing cylinder are then transmitted to a control unit of the printing press and are used for adjusting the bearing blocks precisely to the optimal positions which assure a good print quality from the outset. Each printing cylinder has a reference mark which serves among others for adjusting the longitudinal and side register. Each colour deck has a detector for detecting the reference mark of the printing cylinder that is mounted therein.

[0006] WO 2009/112120 A1 discloses a calibration tool for calibrating such a printing press.

[0007] WO 2009/074295 A1 discloses a printing press wherein the detector is integrated in a removable bearing for the anilox roller.

[0008] It is an object of the invention to provide a printing press in which the reference marks on the printing cylinders can be detected more accurately.

[0009] In order to achieve this object, the detector is arranged in the peripheral surface of the central impression cylinder.

[0010] This has the advantage that the positions of the reference marks of the printing cylinders in all colour decks, as detected with the detector, are directly related to the CI rather than being related to the positions of detectors in the respective colour decks. Consequently, the detection results will not be affected by any possible positional offsets between detectors in the various colour decks. Moreover, the detector can easily be moved into a position where it directly faces the reference mark of the printing cylinder, simply by appropriately rotating the CI. Since the detector is embedded in the surface of the CI, no additional mounting space in the colour deck is necessary for accommodating the detector, nor is it necessary to move the detector into an inoperative position where it does not interfere with the print process.

[0011] More specific embodiments and further developments of the invention are indicated in the dependent claims.

[0012] When only a single detector is provided in the CI for detecting the reference marks of all printing cylinders, the side registers of all printing cylinders can easily be adjusted relative to the single detector.

[0013] In another embodiment, the CI may have a plurality of detectors for detecting the reference marks of a plurality of printing cylinders simultaneously. In this case, any possible offsets between the various detectors can easily be measured and compensated for in a simple calibration procedure which has to be performed only once when the printing press has been installed.

[0014] When the reference mark on the printing cylinder is arranged near one end of the printing cylinder or an adapter sleeve thereof, the CI may have one or more pairs of detectors, with the detectors of each pair being arranged symmetrically near the opposite sides of the CI, so that one of these detectors may face the reference mark on the sleeve regardless of the orientation in which the sleeve has been mounted in the printing press.

[0015] The detector or detectors may communicate with a control unit of the printing press via rotary connectors or, preferably, a wireless link.

[0016] Preferred embodiments of the invention will now be described in conjunction with the drawings, wherein:

Fig. 1	is a schematic view of a rotary printing press and an associated preparation rack;
Fig. 2	is a schematic horizontal cross-section showing essential parts of an individual colour deck in the printing press shown in Fig. 1;
Fig. 3	a top plan view of a mandrel with a calibration tool mounted thereon;
Figs. 4-7	are cross-sectional views of the calibration tool, an anilox roller and a part of a CI in subsequent steps of a calibration procedure;
Fig. 8	is a cross-sectional view of an adapter sleeve of a printing cylinder, an anilox roller and a part of the during detection of a reference mark on the adapter sleeve;
Figs. 9	is a flow diagram of a calibration method;
Fig. 10	is a flow diagram of a process for detecting the reference mark;
Fig. 11	is a schematic view of a rotary printing press according to a modified embodiment; and
Figs. 12 and 13	are top plan views of a printing cylinder and a part of the CI in the printing press shown in Fig. 11.

[0017] Fig. 1 shows a flexographic printing press 10 having a central impression cylinder (CI) 12 and ten colour decks A-J arranged around the periphery thereof. Each colour deck comprises a frame 14 which rotatably and adjustably supports an anilox roller 16 and a printing cylinder 18. As is generally known in the art, the anilox roller 16 is inked by means of an ink fountain and/or a doctor blade chamber (not shown) and may be adjusted against the printing cylinder 18, so that the ink is transferred onto the peripheral surface of the printing cylinder 18 carrying a printing pattern.

[0018] A web 20 of a print substrate is passed around the periphery of the CI 12 and thus moves past each of the colour decks A-J when the CI rotates.

[0019] In Figure 1, the colour decks A-E are shown in the operative state. In this state, the anilox rollers 16 and the printing cylinders 18 are driven to rotate with a peripheral speed that is identical with that of the CI 12, and the printing cylinder 18 is adjusted to the web 20, so that an image corresponding to the respective printing pattern is printed onto onto the web 20. Each of the colour decks A-E operates with ink of a specific colour, so that corresponding colour separation images of a printed image are superposed on the web 20 when it passes through the nips formed between the CI 12 and the various printing cylinders 18 of the successive colour decks.

[0020] In the condition shown in Fig. 1, the other five colour decks F-J are not operating, and their printing cylinders are shifted away from the web 20. While the machine is running, these colour decks F-J may be prepared for a subsequent print job by exchanging the printing cylinders 18 and, as the case may be, also the anilox rollers 16.

[0021] Fig. 1 further shows a schematic front view of a so-called mounter 24, i.e. a rack that is used for preparing a printing cylinder 18 before the same is mounted in one of the colour decks, e.g., the colour deck F. In the example shown, it is assumed that the printing cylinder 18 is of a type carrying one or more printing plates 26 carrying a printing pattern on their outer peripheral surface. As is generally known in the art, the printing cylinder may take the form of a sleeve that is hydraulically or pneumatically clamped on a mandrel of the mounter and the printing press, respectively. The mounter 24 is particularly used for mounting the printing plates 26 on the printing cylinder sleeve, e.g. by means of an adhesive.

[0022] The mounter 24 has a base 28 and two releasable bearings 30 in which the opposite ends of the printing cylinder 18 are rotatably supported. A drive motor 32 is arranged to be coupled to the printing cylinder 18 to rotate the same, and an encoder 34 is coupled to the drive motor 32 for detecting the angular position of the printing cylinder 18.

[0023] A reference mark 36, e.g. a magnet, is embedded in the periphery of the printing cylinder 18, and a detector 38 capable of detecting the reference mark 36 is mounted on the base 28 in a position corresponding to the axial position of the reference mark. The detector 38 may for example be a 3-axes hall detector capable of accurately measuring the position of the reference mark 36 in a 3-dimensional co-ordinate system having axes X (normal to the plane of the drawing in Figure 1), Y (in parallel with the axis of rotation of the printing cylinder 18) and Z (vertical in Fig. 1).

[0024] When the printing cylinder 18 is rotated into the position shown in Fig. 1, where the reference mark 36 faces the detector 38, the detector 38 measures an offset of the reference mark 36 relative to the detector 38 in Y-direction as well as an offset in X-direction. The offset in X-direction is determined by the angular position φ of the printing cylinder 18. Thus, even when the reference mark 36 is not exactly aligned with the detector 38, it is possible to derive a well defined Y-position and a well defined angular (φ) position which may serve as a reference point for defining a cylindrical φ-Y-R coordinate system that is fixed relative to the printing cylinder 18 (the R-coordinate being the distance from a point on the axis of rotation of the printing cylinder, as defined by the bearings 30). The position data defining this reference point are stored in a control unit 40 of the mounter 24.

[0025] The mounter 24 further comprises a rail 42 that is mounted on the base 28 and extends along the outer surface of the printing cylinder 18 in Y-direction. A roller-type height detector 44 (which may for example be of the type disclosed in WO 2008/049500 A2) is guided on the rail 42 and may be driven to move back and forth along the rail 42 so as to scan the surface of the printing cylinder 18 and, in particular, the surfaces of the printing plates 26. The rail 42 further includes a linear encoder which detects the Y-position of the height detector 44 and signals the same to the control unit 40. When the printing cylinder 18 is rotated, the encoder 34 counts the angular increments and signals them to the control unit 40, so that the control unit 40 can always determine the φ and Y-coordinates of the height detector 44 in the cylindrical coordinate system that is linked to the reference mark 36 of the printing cylinder.

[0026] The height detector 44 detects the height of the surface point of the printing cylinder 18 (or printing plate 26) that is located directly underneath the current position of the height detector. The height determined in this way can be represented by the R-coordinate in the cylindrical coordinate system. Thus, by rotating the printing cylinder 18 and moving the height detector 44 along the rail 42, it is possible to scan the entire peripheral surface of the printing cylinder 18 and to capture a height profile or topography of that surface with an accuracy that may be as high as 1-2 μm, for example. To this end, the mounter may be calibrated to map inherent deviations of the rail 42, which will then be combined in the control unit 40 with the readings from the height detector 44 so as to establish a more accurate topography.

[0027] In this way, the exact geometrical shape of the printing cylinder 18 (including the printing plates) can be determined with high accuracy in the control unit 40. In particular, it is possible to detect whether the surface of the printing cylinder has a circular or rather a slightly elliptic cross-section. If the cylinder is found to have an elliptic cross section, the azimuth angle of the large axis of the ellipse can be determined. Likewise, even if the cross section of the surface of the printing cylinder is a perfect circle, it is possible to detect whether the centre of this circle coincides with the axis of rotation that is defined by the bearings 30. If this is not the case, the amount of the offset and its angular direction can also be detected and recorded. In principle, all this can be done for any Y-position along the printing cylinder 18. Moreover, it is possible to detect whether the diameter of the printing cylinder 18 varies in Y-direction. For example, it can be detected whether the printing cylinder has a certain conicity, i.e., whether its diameter slightly increases from one end to the other. Similarly, it can be detected whether the printing cylinder bulges outwardly (positive crown) or inwardly (negative crown) in the central portion. In summary, it is possible to gather a number of parameters that indicate the average diameter of the printing cylinder 18 as well as any possible deviations of the shape of the peripheral surface of the printing cylinder from a perfect cylindrical shape.

[0028] When the printing cylinder 18 has been scanned in the mounter 24, it is removed from the mounter so that it may be inserted in one of the colour decks of the printing press 10. When, for example, the printing cylinder that has been removed from the mounter 24 is to replace the printing cylinder in the colour deck F, the topography data detected by means of the height detector 44 and stored in the control unit 40 are transmitted through any suitable communication channel 48 to a control unit 50 of the printing press.

[0029] As is further shown for the colour deck F in Figure 1, a detector 52 (e. g. a 3-axes hall detector) for detecting the reference mark 36 of the printing cylinder 18 is arranged in an appropriate position in the peripheral surface of the CI 12. Thus, by detecting the position of the reference mark 36 with the detector 52 after the printing cylinder has been mounted in the colour deck F and has been set against the CI, it is possible to transform the topography data obtained from the mounter 24 into a local coordinate system of the printing press. Then, the position of the printing cylinder 18 in the colour deck F may be adjusted on the basis of these data, as will be explained below in conjunction with Fig. 2. By rotating the CI 12, one and the same detector 52 may successively be brought into suitable positions for detecting the reference marks 36 on the printing cylinders in any colour deck.

[0030] Fig. 2 shows only a peripheral portion of the CI 12 as well as certain portions of the colour deck F which serves to rotatably and adjustably support the printing cylinder 18. These portions of the colour deck comprise stationary frame members 56, 58 on the drive side and the operating side of the printing press 10, respectively. The frame member 58 on the operating side has a window 60 through which, when the printing cylinder is to be exchanged, the old printing cylinder is removed and the new one is inserted. In practice, rather than exchanging the printing cylinder 18 in its entirety, it may be convenient to exchange only a printing cylinder adapter sleeve that is mounted on a cylinder core or mandrel, as is well known in the art.

[0031] The frame member 58 carries a releasable and removable bearing 62 that supports one end of the printing cylinder 18. This bearing 62 is slidable towards and away from the CI 12 along a guide rail 64, and a servo motor or actuator 66 is provided for moving the bearing 62 along the guide rail 64 in a controlled manner and for monitoring the positions of the bearing 62 with high accuracy.

[0032] The frame member 56 on the drive side of the printing press has a similar construction and forms a guide rail 68 that supports a bearing 70 and a servo motor or actuator 72. Here, however, an axle 74 of the printing cylinder extends through a window of the frame member 56 and is connected to an output shaft of a drive motor 76 through a coupling 78. The drive motor 76 is mounted on a bracket 80 that is slidable along the frame member 56, so that the drive motor may follow the movement of the bearing 70 under the control of the actuator 72. Thus, the position of the printing cylinder 18 relative to the CI 12 along an axis X' (defined by the guide rails 64, 68) may be adjusted individually for either side of the printing cylinder. In this way, it is possible to set the pressure with which the printing cylinder 18 presses against the web on the CI 12 and also to compensate for a possible conicity of the printing cylinder.

[0033] The axle 74 of the printing cylinder 18 is axially slidable in the bearings 62, 70 (in the direction of an axis Y'), and the drive motor 76 has an integrated side register actuator 76' for shifting the printing cylinder in the direction of the axis Y'.

[0034] Further, the drive motor 76 includes an encoder 82 for monitoring the angular position of the printing cylinder 18 with high accuracy.

[0035] The detector 52, which may have a similar construction as the detector 38 in the mounter 24, is mounted on the CI 12 in an axial position that corresponds to the axial position of the reference mark 36 on the printing cylinder. Thus, the reference mark 36 may be rotated into a position in which it faces the CI, and the detector 52 may be rotated into a position in which it faces the reference mark 36 and may detect the position thereof with high accuracy. The detector 52 is embedded in the surface of the CI so that it will not disturb the print process.

[0036] When the printing cylinder 18 is mounted in the colour deck F, the drive motor 76 is held at rest in a predetermined home position, and the coupling 78 may comprise a conventional notch and key mechanism (not shown) which assures that the angular position of the reference mark 36 will roughly correspond to a predetermined zero position. Then, using the drive motor 76 and the encoder 82, the printing cylinder is rotated into the position where the reference mark 36 will face the nip between the printing cylinder and the CI. The CI is rotated into a position where the detector 52 will face the same nip, and afterwards the actuators 66 and 72 are driven to move the printing cylinder against the CI so as to form the nip therewith. Then, the precise offset of the reference mark 36 relative to the detector 52 in Y'-direction and the precise angular offset are measured in the same way as has been described in conjunction with the detector 38 of the mounter. The measured offset data are supplied to the control unit 50 which also receives data from the encoder 82 and the side register actuator 76'. These data permit to determine the angular position and the Y'-position of the printing cylinder 18 in a machine coordinate system.

[0037] By reference to the topography data delivered via the communication channel 48 and by reference to the Y' position provided by the side register actuator 76' and the offset data provided by the detector 52, the control unit 50 calculates the Y' position of the printing pattern on the printing plates 26 in the machine coordinate system and then controls the actuator 76' to precisely adjust the side register.

[0038] The angular positions of the printing cylinder 18 are monitored on the basis of the data supplied by the encoder 82. By reference to the topography data and the offset data from the detector 52, the control unit 50 calculates the actual angular positions of the printing pattern on the printing plates 26 and advances or delays the drive motor 76, thereby to adjust the longitudinal register.

[0039] If only a single detector 52 is provided on the CI 12, then this detector will serve as a common reference for the Y'-offsets of the reference marks 36 in all colour decks, so that the side registers of all printing cylinders can be adjusted very precisely.

[0040] The control unit 50 includes a memory 84 which stores calibration data. These calibration data include, for example, the X' positions of the printing cylinders 18 when they are set against the CI 12, the angular positions of the CI and the printing cylinders where the detector 52 faces the respective reference marks 36, and the like. It should be noted here that the X'-direction defined by the guide rails 64, 68 is not necessarily normal to the surface of the CI 12 at the nip formed with the printing cylinder 18, so that the calibration data for the X'-position may depend upon the angle formed between the normal on the surface of the CI and the X'-direction.

[0041] A method for obtaining such calibration data will now described in conjunction with Figs. 3 to 8.

[0042] Fig. 3 shows a mandrel 88 that forms part of the printing cylinder 18 and is supported in the bearings 62, 70. During the print process, this mandrel carries an adapter sleeve (not shown) that carries, for example, an air-mounted printing sleeve with the printing pattern or printing plates thereon. In Fig. 3, however, this adapter sleeve has been replaced by a calibration tool 90 that has the same dimensions as a typical adapter sleeve and can hydraulically be clamped on the mandrel 88 in the same manner as a normal adapter sleeve. The calibration tool 90 is made of a rigid material which has a high shape- and dimensional stability and a low thermal expansion coefficient. A particular preferred material is a carbon fibre composite with carbon fibres embedded in a resin matrix. In the vicinity of each end of the calibration tool 90, a precision switch 92 is embedded therein such that a contact sensitive part of the switch is exposed in the peripheral surface of the tool. Instead of contact-sensitive switches, it is also possible to use distance detectors that are capable of detecting an object in a short distance from the tool and to measure that distance exactly.

[0043] In a central part of the calibration tool 90, an inclinometer 94 is embedded in the tool 90.

[0044] Each of the precision switches 92 and the inclinometer 94 are capable of communicating with the control unit 50 (Fig. 2), preferably through a wireless communication channel. As an alternative, they may be connected to the control unit 50 via wirelines and sliding contacts in the bearings.

[0045] In Fig. 4, the calibration tool 90, the anilox roller 16 and a part of the CI 12 are shown in a cross-sectional view. When a calibration process is to be performed, the calibration tool 90 is rotated into a position in which the inclinometer 94 faces upwards. The inclinometer 94 is of a commercially available type and is capable of detecting inclinations in both, the left/right direction in Fig. 4 and the direction normal to the plane of the drawing with an accuracy as high as 0.1 arc seconds, for example. The axis of the inclinometer is exactly coincident with the radial direction of the tool 90. On the basis of the inclination signals delivered by the inclinometer 94, the tool 90 is rotated into a position in which the inclination (in left/right direction in Fig. 4) is exactly zero (vertical), and the corresponding angular position of the tool 90, detected by the encoder 82, is stored as an angular reference position for the drive motor 76 and the mandrel 88. In this position, the switches 92 face the CI 12. They are however vertically offset from the axis of the CI, depending on the colour deck to which the mandrel 88 belongs.

[0046] Then, as is shown in Fig. 5, the drive motor 76 is driven to rotate the tool 90 into a position in which the switches 92 are located on the line of contact where the tool 90 will meet the peripheral surface of the CI 12 once the tool 90 is driven in X'-direction against the CI. The necessary angle of rotation can roughly be determined on the basis of the height of the pertinent colour deck relative the CI.

[0047] In the next step, shown in Fig. 6, the actuators 66 and 72 (Fig. 2) are operated to move the tool 90 against the CI 12, until the precision switches 92 detect the peripheral surface of the CI. The precision switches 92 are of a commercially available type (e.g. MY-COM switches) and are capable of detecting contact with the CI with a positional accuracy of 1 μm. As soon as the switches 92 send detection signals to the control unit 50, the actuators 66, 72 are stopped, and the positions of the actuators, corresponding to the X'-position of the mandrel 88, are recorded as reference positions.

[0048] Theoretically, the detection signals of both switches 92 should be received simultaneously. However, slight differences may occur when the axis of the mandrel 88 is not exactly parallel with the axis of the CI 12 or, more precisely, the corresponding part of the peripheral surface of the CI. Since the actuators 66 and 72 for the opposite ends of the mandrel 88 are controlled independently from one another, it is possible to detect independent reference positions in which both switches 92 engage the peripheral surface of the CI.

[0049] Moreover, since the inclinometer 94 is a two-dimensional inclinometer, it is also possible in the position shown in Fig. 4, to detect a possible inclination of the axis of the mandrel 88. In principle, this inclination can be measured for any position of the mandrel 88 in X'-direction.

[0050] Fig. 7 illustrates a condition in which the tool 90 has been rotated into a position in which a radius from the central axis of the mandrel 88 to the switches 92 is exactly parallel with the X'-direction, and the switches face the anilox roller 16. This rotation may optionally be performed after the mandrel 88 has slightly been withdrawn from the CI 12 so as to avoid friction. Then, as has also been shown in Fig. 7, the anilox roller 16 is moved in X'-direction against the tool 90 until the switches 92 detect contact between the anilox roller and the calibration tool, thereby to detect a reference position for the anilox roller 16 and X'-direction. Again, independent reference positions are detected for both ends of the anilox roller. Of course, it would also be possible to move the calibration tool 90 until it abuts against the anilox roller 16.

[0051] The calibration process that has been described above needs to be performed only once when the printing press has been installed. Then, when a print run is to be started, the calibration tool 90 is replaced by an adapter sleeve 96 that carries the printing pattern or printing plates and, together with the mandrel 88, forms the printing cylinder 18 as shown in Fig. 8. Using the data that have been stored in the calibration process, the printing cylinder 18 is moved to the position that corresponds to the position of the calibration tool 90 in Fig. 6, and the printing cylinder is rotated until the reference mark 36 faces the CI 12, as shown in Fig. 8.

[0052] The CI 12 has been rotated into a position in which the detector 52 faces the reference mark 36. The corresponding angular position of the CI can be calculated from the height of the pertinent colour deck.

[0053] The detector 52 is now capable of detecting the offset of the reference mark 36 in axial direction, so that the side register can be adjusted on the basis of this offset. The detector 52 is also capable of detecting the offset of the reference mark 36 in circumferential direction, and in combination with the known radii of the CI and the adapter sleeve 96 (which may be different from the radius of the calibration tool 90), this offset can be transformed into an angular offset of the printing cylinder 18 and/or the CI. In conjunction with the known angular positions of the printing cylinder 18 and the CI 12 in the condition shown in Fig. 8, this angular offset permits to relate the angular position of the printing cylinder 18 exactly to the angular position of the CI 12, thereby to provide a precise reference for the longitudinal register in the printing process. When the radius of the adapter sleeve 96 is different from that of the calibration tool 90, a corresponding correction of the reference can easily be calculated.

[0054] The essential steps of the processes that have been described above are summarised in a flow diagram in Fig. 9.

[0055] In step S1, the calibration tool 90 is mounted on the mandrel 88 of the colour deck to be calibrated.

[0056] Then, in step S2, the inclinometer is adjusted to the vertical position and the corresponding reading of the encoder 82 is stored.

[0057] In step S3, the calibration tool 90 is rotated into the position of Fig. 5 where the switches 92 are ready to detect the surface of the CI.

[0058] In step S4, the calibration tool 90 is driven against the CI.

[0059] The reference positions in X'-direction, for both sides of the calibration tool 90, are detected in step S5.

[0060] In step S6, the calibration tool is rotated into the position in which the switches 92 may contact the anilox roller.

[0061] In step S7, the calibration tool is driven against the anilox roller (or vice versa).

[0062] The reference positions of the anilox roller and the calibration tool in X'-direction are detected and stored in step S8.

[0063] This procedure will be repeated for each of the colour decks A-J (step S9).

[0064] Fig. 10 is a flow diagram of a process for detecting the reference mark. This process will be executed when a new printing cylinder or a new adapter sleeve has been mounted.

[0065] In step S101, the adapter sleeve is mounted.

[0066] In step S102, the printing cylinder is rotated into a position where the reference mark may face the surface of the CI.

[0067] In step S103, the CI is rotated so as to bring the detector 52 into a corresponding detection position.

[0068] In step S104, the actuators 66 and 72 are activated to move the printing cylinder into a position where it makes contact with the CI.

[0069] In step S105, the offsets between the reference mark 36 and the detector 52 in both, lateral direction and circumferential direction are measured with the detector 52 and stored.

[0070] In step S106, the longitudinal register and the side register are adjusted on the basis of the offsets stored in step S105. Of course, the longitudinal register may also be adjusted later by appropriately advancing or delaying the rotary movement of the printing cylinder.

[0071] The steps S 101-S106 will then be repeated for each colour deck (step S107).

[0072] Fig. 11 shows a view of the CI 12 similar to the view shown in Fig. 1, but for a modified embodiment of the printing press. In this embodiment, a plurality of detectors 52 are embedded in the periphery surface of the CI 12, in angular positions corresponding to those of associated colour decks (F-J in this example). Consequently, it is possible in this embodiment to perform the steps S101 to S106 in Fig. 10 simultaneously for the colour decks F-J.

[0073] Of course, in this embodiment, the lateral positions of the various detectors 52 should be aligned with high accuracy. That any possible lateral offsets between the various detectors 52 may be measured in a calibration procedure using a slightly modified calibration tool. This calibration tool has a reference mark corresponding to and arranged in a same position as the reference marks 36 on the adapter sleeves. In the calibration process, the calibration tool is rotated into a position where its reference mark faces the CI, and the CI is successively rotated into positions where the detectors 52 face the reference mark of the calibration tool. Thus, each detector 52 can measure its own lateral offset relative to the reference mark of the single calibration tool. As a result, the lateral offsets of the detectors 52 relative to one another will be known and can be used for an appropriate compensation.

[0074] As is further shown in Fig. 11, an induction ring 98 is provided on an end face of the CI 12. As is shown in Fig. 12, a stationary induction ring 100 is mounted on the machine frame in a position where it faces the induction ring 98 and forms a narrow gap therewith.

[0075] By means of the induction rings 98, 100, electric power for the detectors 52 can inductively be coupled into the CI 12. Similarly, the detection results provided by the detectors 52 can inductively be transmitted to the machine frame and then to the control unit 50 via the induction rings 98, 100.

[0076] As is further shown in Fig. 12, the printing cylinder 18 has an RFID chip 102 which stores the topography data and/or set data that have previously been obtained in the mounter 24 (Fig. 1). The RFID chip 102 is embedded in the peripheral surface of the printing cylinder 18 in an angular position in which it faces the CI when the reference mark 36 faces the detector 52. An annular antenna 104 is embedded in the CI 12 in the same axial position as the RFID chip 102, so that the data from the RFID chip may be read. The power for the antenna 104 will also be provided via the induction rings 98, 100.

[0077] In the embodiment shown in Fig 12, a pair of detectors 52 are arranged in the same annular position and symmetrically near both ends of the CI 12. In the condition shown in Fig. 12, the top one of the detectors 52 is used for detecting the reference mark 36. However, when the printing cylinder 18 or an adapter sleeve thereof is mounted in reverse orientation, as is shown in Fig. 13, the other (lower) detector 52 may be used for detecting the reference mark.

[0078] Again, any possible positional offsets between the detectors 52 of each pair may be measured in a calibration process, using a calibration tool which has two reference marks (magnets) in positions corresponding to those of the detectors 52. Of course, the same calibration tool will be used for measuring the offsets of all pairs of detectors 52.

[0079] As an alternative, the offsets between the detectors of each pair and the offsets between detectors 52 in different angular positions of the CI 12 may be measured in a test print. Then, the calibration tool 90 shown in Fig 3 may also be used for calibrating the printing press shown in Figs. 11 to 13.

Claims

1. A rotary printing press comprising a central impression cylinder (12) and a plurality of colour decks (A-J) disposed at the periphery thereof, each colour deck including a printing cylinder (18) adapted to be set against the central impression cylinder (12) and having a reference mark (36) arranged in its peripheral surface, the printing press further including a detector (52) for detecting the reference mark (36), **characterized in that** the detector (52) is arranged in the peripheral surface of the central impression cylinder (12).

2. The rotary printing press according to claim 1, wherein the reference mark (36) is a magnet.

3. The rotary printing press according to claim 2, wherein the detector (52) is a hall detector.

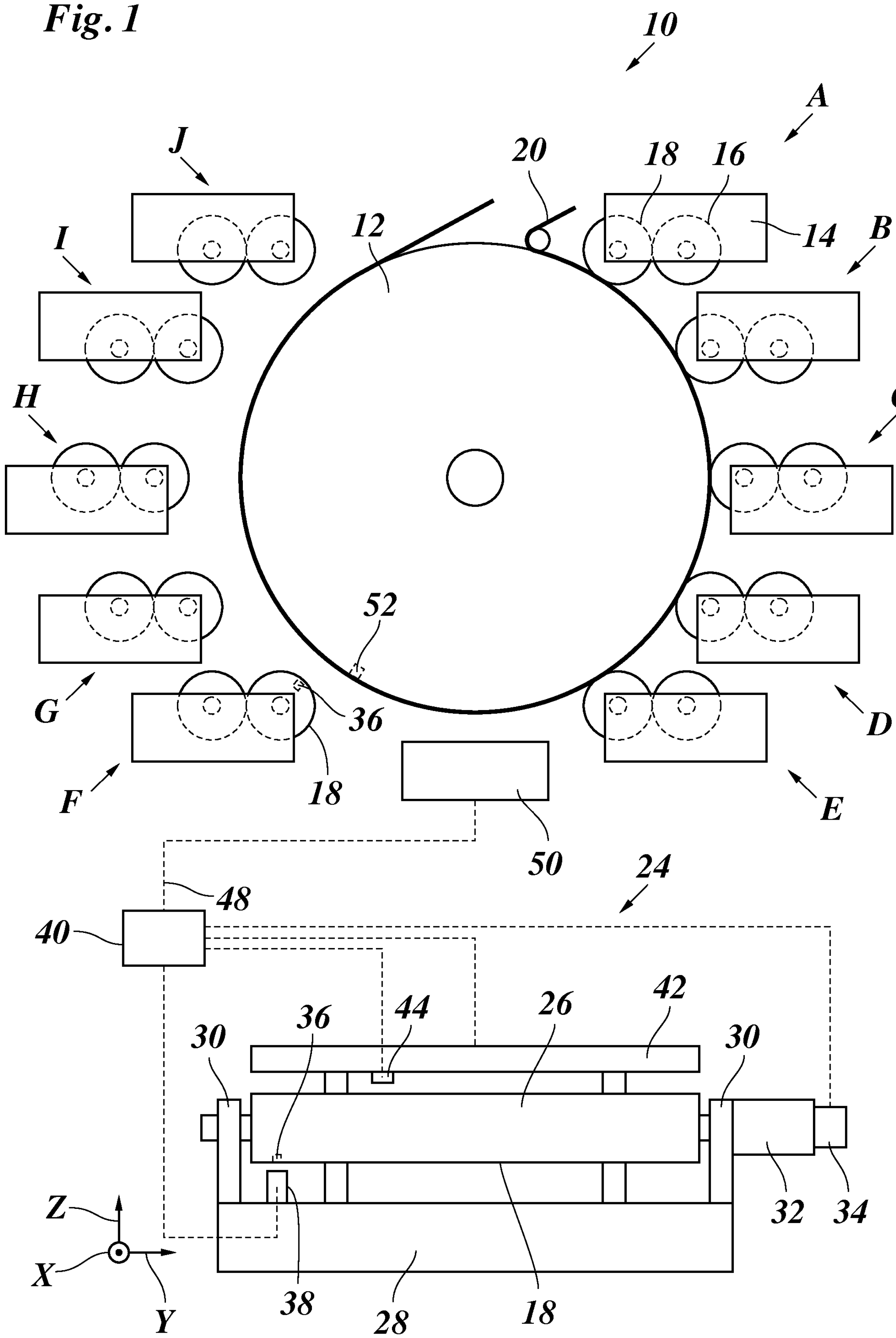
4. The rotary printing press according to any of the preceding claims, wherein the central impression cylinder (12) has a plurality of detectors (52) arranged in circumferential positions corresponding to those of a plurality of colour decks (F-J).

5. The rotary printing press according to any of the preceding claims, wherein the central impression cylinder (12) has at least one pair of detectors (52) arranged in the same circumferential position and in longitudinal positions near opposite ends of the central impression cylinder (12) and symmetric with respect to the centre of the central impression cylinder.

6. The rotary printing press according to the any of the preceding claims, comprising a pair of induction rings (98, 100), one of which is provided on an end face of the central impression cylinder (12) while the other one (100) is mounted on a machine frame in a position facing the induction ring (98) of the central impression cylinder for inductively transmitting electric power to the detector or detectors (52).

7. The rotary printing press according to any of the preceding claims, wherein each printing cylinder (18) has an RFID chip (102) arranged in a peripheral surface thereof and the central impression cylinder (12) includes at least one antenna (104) arranged for reading the RFID chips (102).

Fig. 1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18
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44
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Z
X
Y
38
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34

Fig. 2

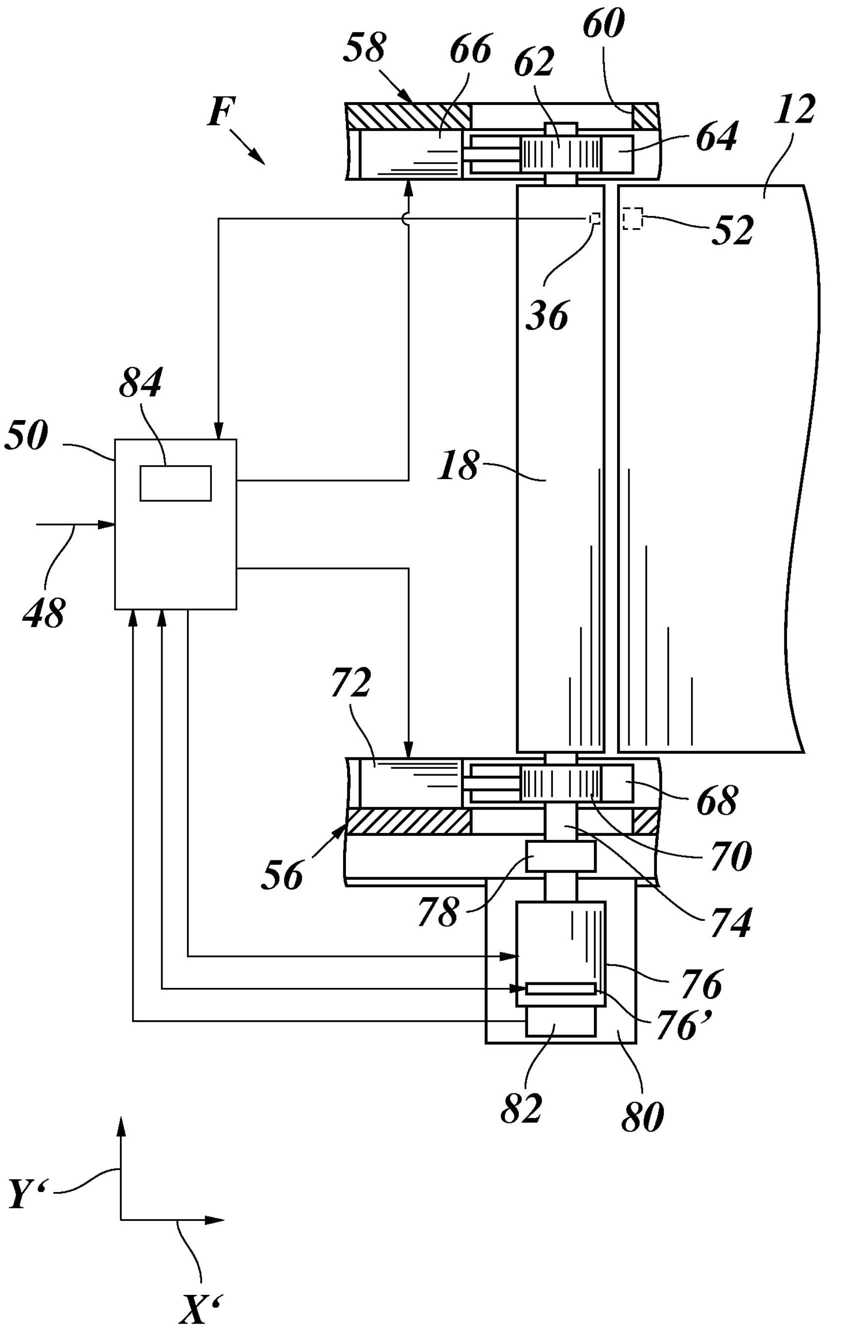


Fig. 3

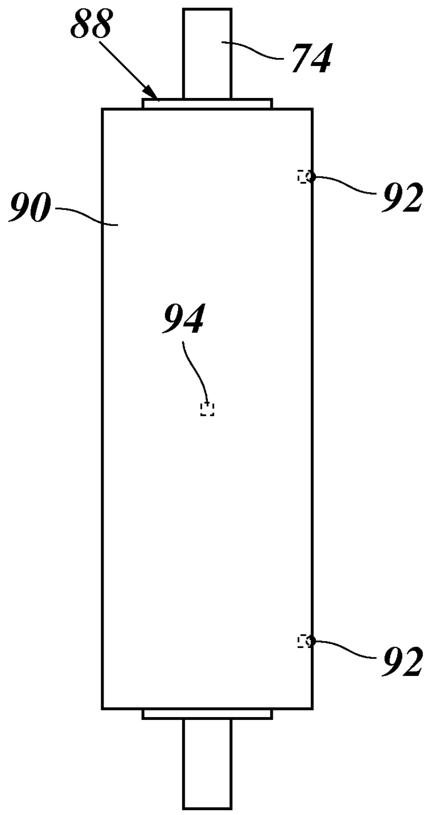


Fig. 4

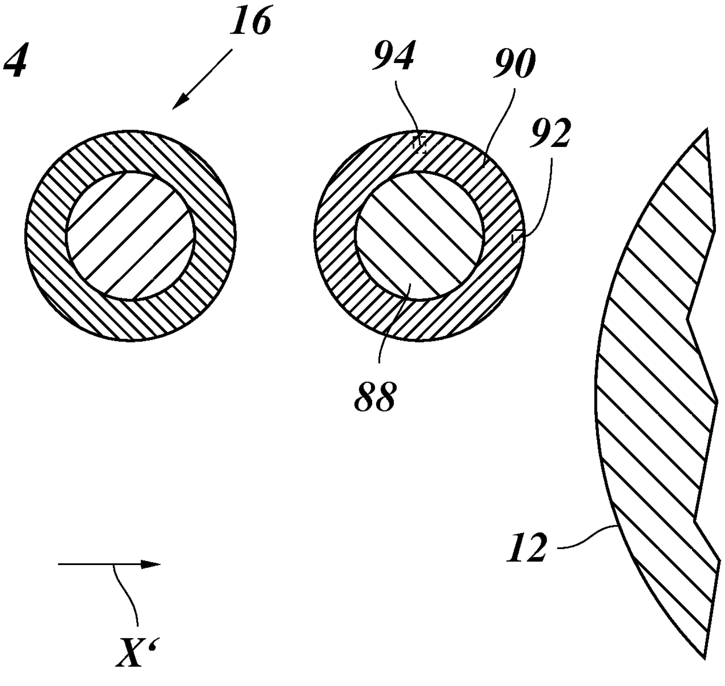


Fig. 5

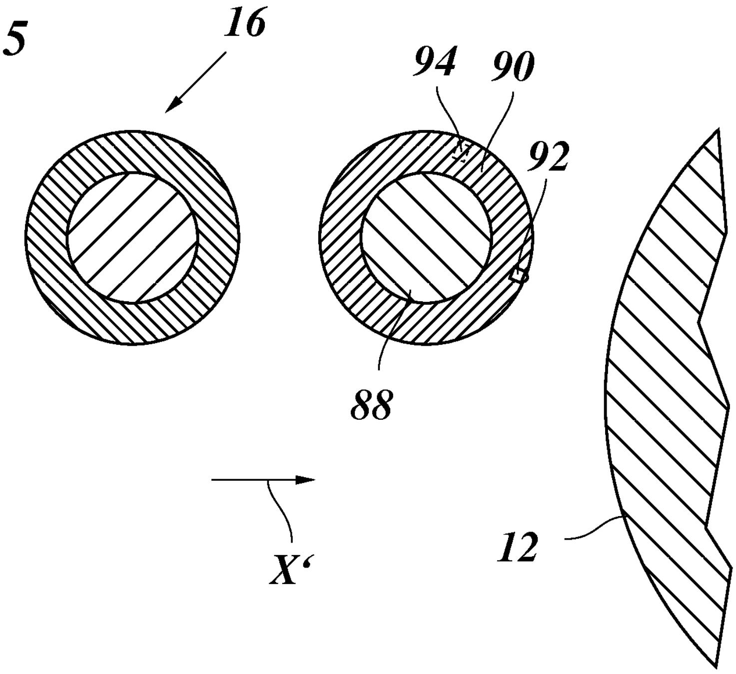


Fig. 6

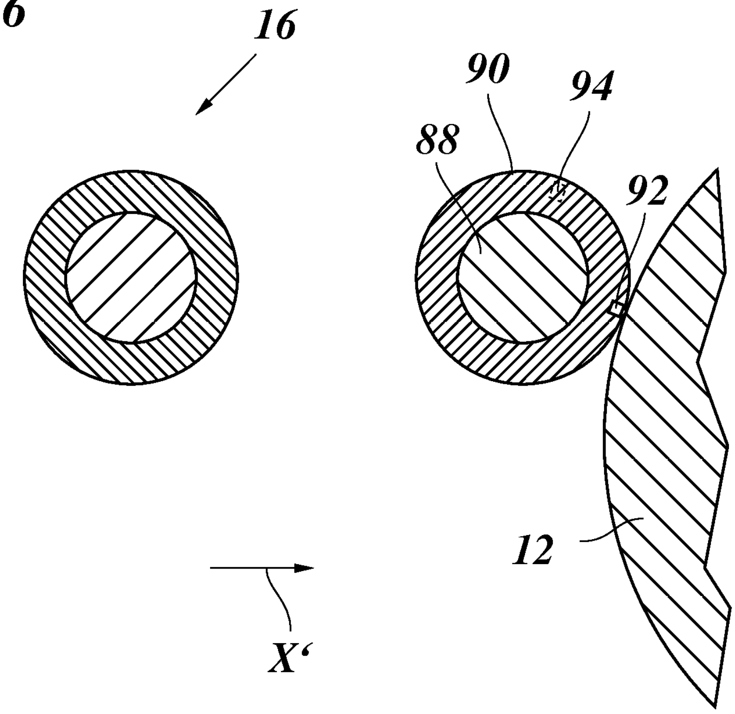


Fig. 7

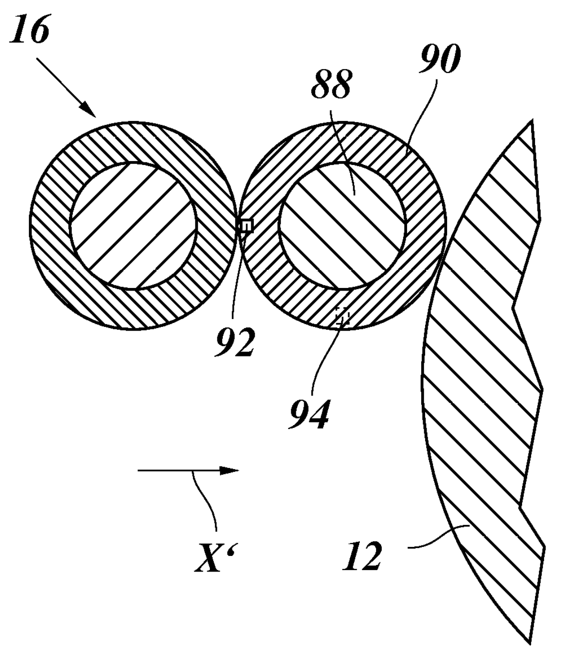


Fig. 8

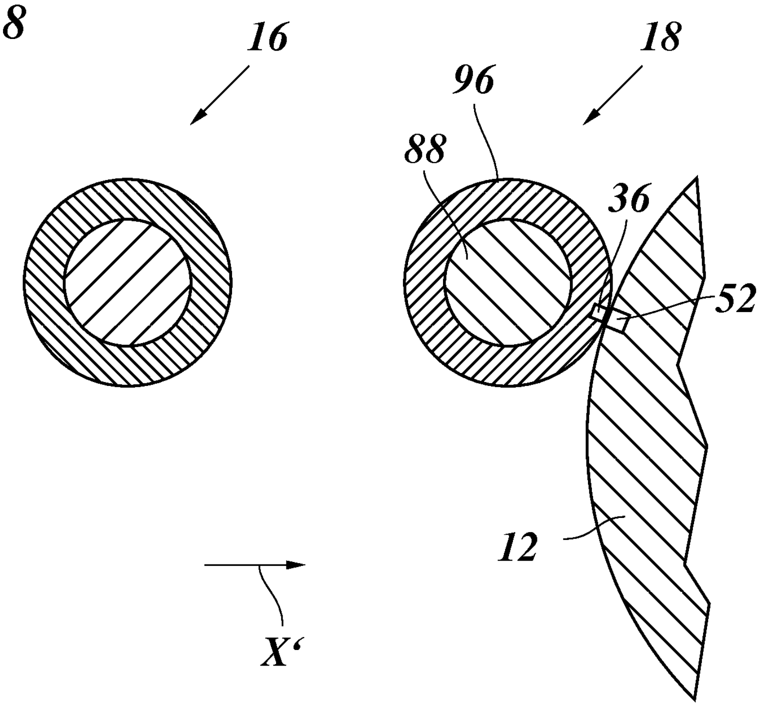


Fig. 9

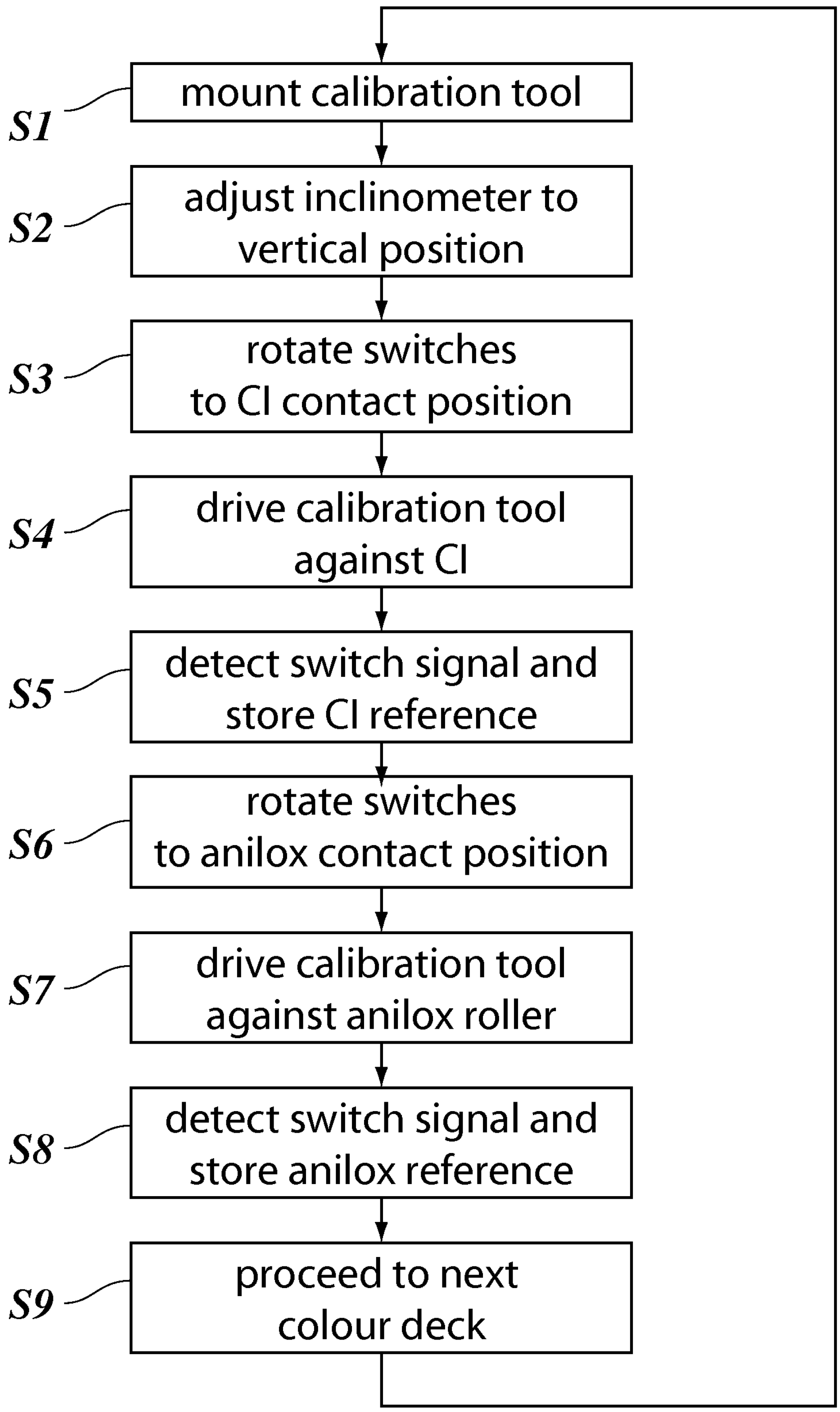

S1
mount calibration tool
S2
adjust inclinometer to vertical position
S3
rotate switches to CI contact position
S4
drive calibration tool against CI
S5
detect switch signal and store CI reference
S6
rotate switches to anilox contact position
S7
drive calibration tool against anilox roller
S8
detect switch signal and store anilox reference
S9
proceed to next colour deck

Fig. 10

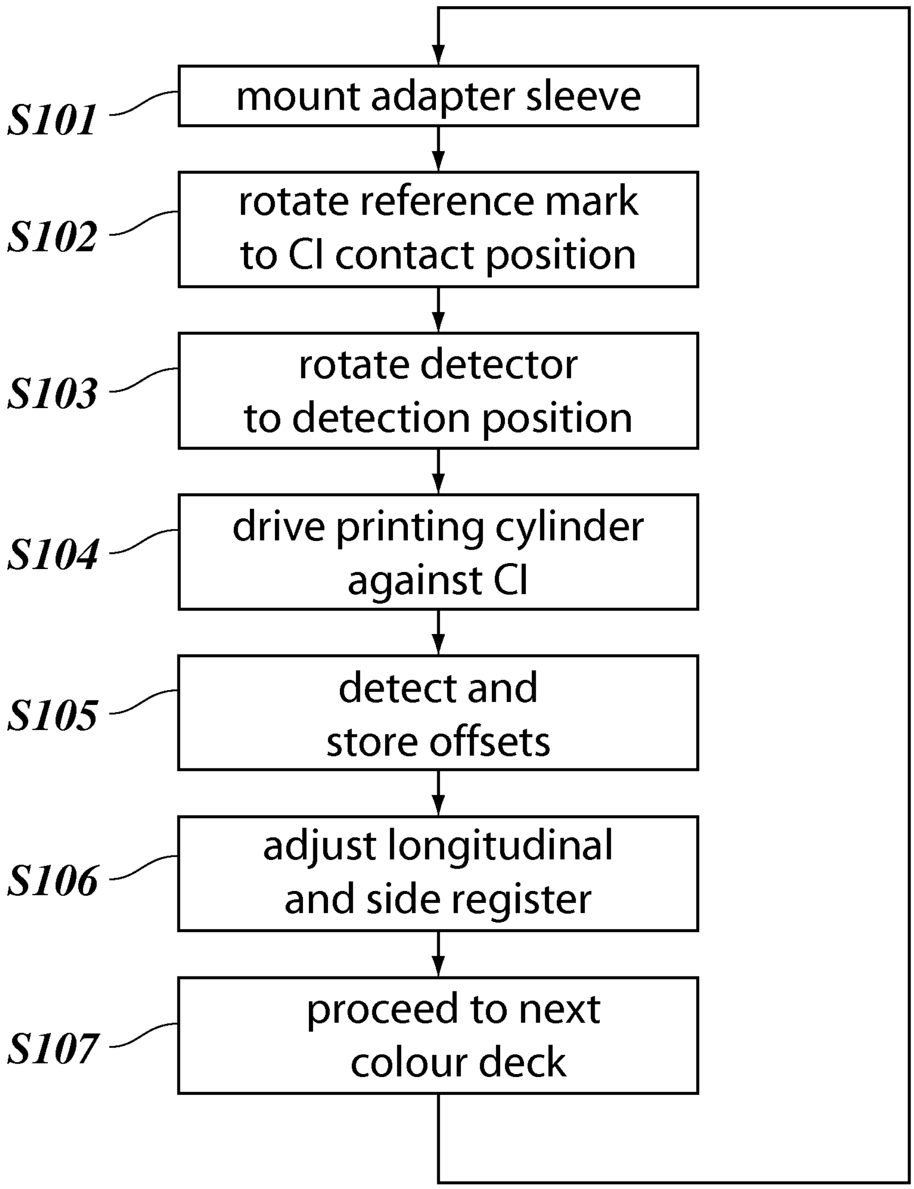

S101
mount adapter sleeve
S102
rotate reference mark to CI contact position
S103
rotate detector to detection position
S104
drive printing cylinder against CI
S105
detect and store offsets
S106
adjust longitudinal and side register
S107
proceed to next colour deck

Fig. 11

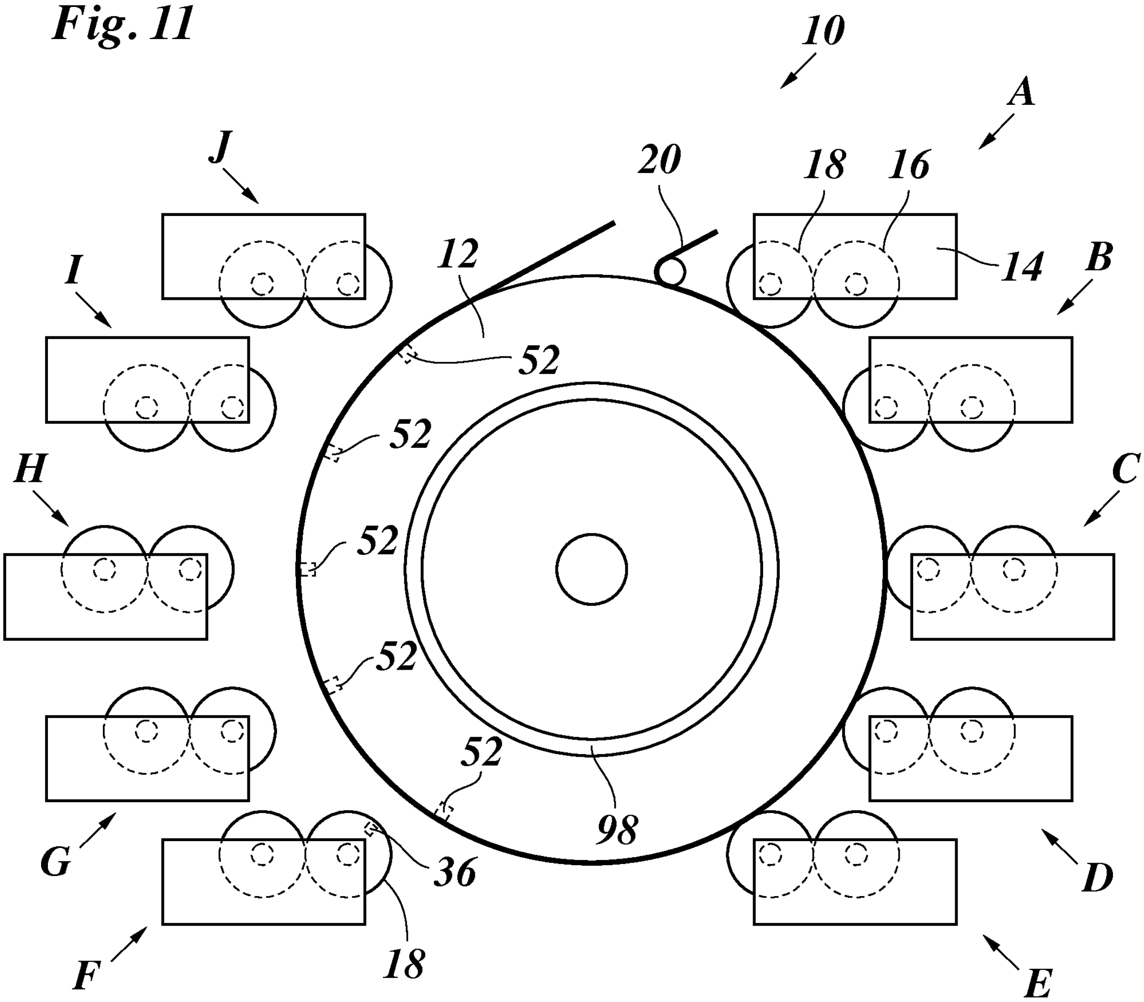


Fig. 12

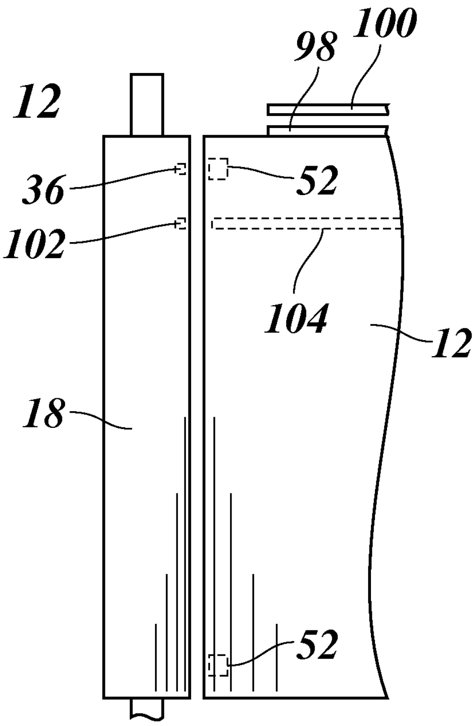
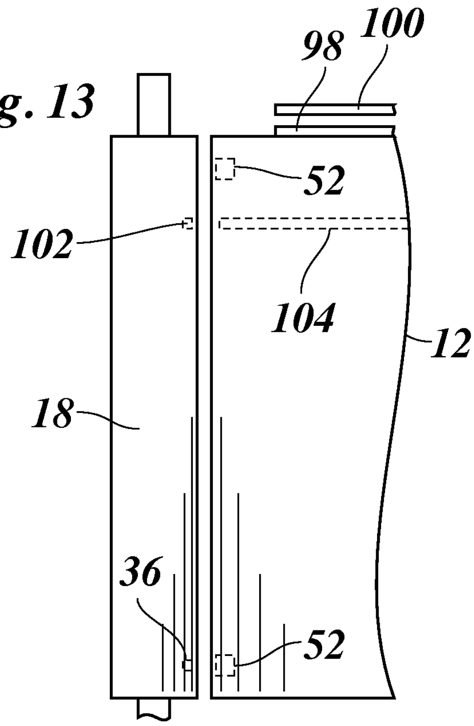


Fig. 13



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EUROPEAN SEARCH REPORT

Application Number
EP 10 17 4576

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			B41F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	18 January 2011	Axters, Michael

CATEGORY OF CITED DOCUMENTS

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18-01-2011

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