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71 Applicant: **KABUSHIKIGAISHA TOKYO KIKAI
SEISAKUSHO**
26-24, Shiba 5-chome Minato-ku
Tokyo(JP)

72 Inventor: **Shiba, Noriyuki**
44-19, Kamimeguro-3-chome Meguro-ku
Tokyo(JP)
Inventor: **Okamura, Yuichi**
44-11, Kamimeguro-3-chome Meguro-ku
Tokyo(JP)
Inventor: **Kawahara, Kohmei**
16-18, Nishimagome-1-chome Ohta-ku
Tokyo(JP)

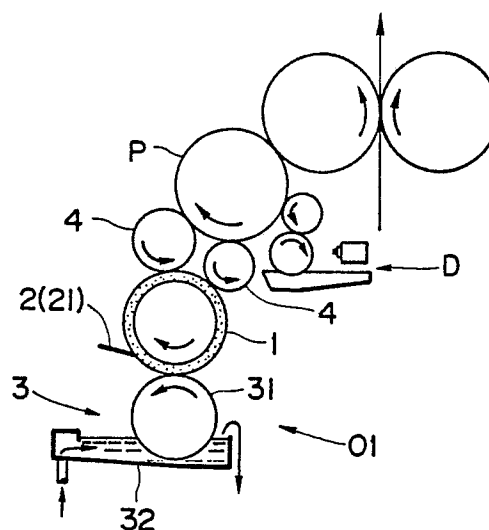
74 Representative: **Patentanwälte Deufel- Schön-
Hertel- Lewald- Otto**
Isartorplatz 6
D-8000 München 2(DE)

54 **Multicolor printing machine and method of multicolor printing.**

57 This invention is related to a multicolor printing machine and a multicolor printing method which uses a multicolor printing machine. A plurality of inking rollers in a multicolor rotary printing machine are provided with an ink receiving layer on the roller surface, and the ink receiving layer has minute hollow bodies dispersed in it, and those minute hollow bodies which are located on the surface of the ink receiving layer are open. Furthermore, each inking roller is constituted with a roller which is suitable for the physical properties of the ink fluid that is used for the inking roller.

With this invention it is possible to furnish proper ink which is supplied to an inking roller and finished prints are excellent. With this invention it is possible to provide a multicolor rotary printing machine with a long life in its inking rollers and present a multicolor printing method.

FIG. 1



EP 0 367 193 A2

MULTICOLOR PRINTING MACHINE AND METHOD OF MULTICOLOR PRINTING

BACKGROUND OF THE INVENTION

(1) Field of the Invention

This invention is related to a multicolor rotary printing machine and a method of multicolor printing, and in particular to a multicolor rotary printing machine which uses a keyless ink furnishing device for removing the excessive ink or surplus ink by providing an ink removal device in contact with the surface of an inking roller and to a multicolor printing method which employs the keyless ink furnishing.

(2) Description of the Prior Art

The keyless ink furnishing device has been used in the field of flexographic printing. It has an ink metering roller or so-called anilox roller on the surface of which minute carved cells of an exquisite and substantially fixed shape are arranged regularly, and ink removal member (for instance blade) to remove excessive ink which is received in the cells, both the ink metering roller and the blade working together, and the ink received in the cells are furnished to the plate during the printing operation. In recent years in the fields other than the flexographic printing the letter-press printing and offset printing also employ a keyless ink furnishing device which used an anilox roller (refer to "Latest Main Newspaper Printing Machinery 1986" published by Japan Newspaper Association, 17 May 1986, from Page 323 left column 22 to page 325 left column 12).

The anilox roller which is used for those keyless ink furnishing devices has its carved cells formed by form rolling or laser beam machining. Sometimes the surface with those cells is covered with an adequate material as needed when used for printing.

Further, multicolor printing which employs an above mentioned keyless ink furnishing device can be lately seen (refer to 'Printing Magazine, March 1988' Vol.71, No.3 published by Printing Technology Association, 15 March 1988 and 'Printing News No.393' Page 3, 5 June 1988 published by Printing News Publishing Co. 10-26-1, Tachibana-Cho, Amagasaki City). In the multicolor printings reported in the foregoing publications anilox rollers which have the cells of different sizes according to different ink are used.

In the conventional keyless ink furnishing de-

vices the device furnishes ink which has been taken in the cells to the plate by an anilox roller which has on its surface the above mentioned minute cells of a small depth and adequate ink removal member (for instance blade or roller), both the anilox roller and minute cells working in cooperation. In the printing operation the anilox roller and ink removal member are constantly in contact with each other so that wear develops between them, and the keyless ink furnishing device can not maintain a constant quality of printing on the print because the volume in each cell is reduced as the wear of the anilox roller proceeds even if the wear is very small. When the wear develops over a certain extent (for instance, about 10% of the initial depth of the cell which is usually less than 30 μm), a required amount of ink can not be furnished to the surface of a plate. This means that the anilox roller should be replaced after a relatively short period of use, and the availability factor of a printing machine of this type had been low.

Furthermore, the anilox roller required complicated work processes for making the cells and a long time was taken for it, making the cost of manufacturing anilox rollers high. With the high frequency of anilox roller replacement the high running cost of printing machine presented a problem.

If, in the multicolor printing method or multicolor printing machines which employ a conventional anilox roller, the fluidity of ink changes according to the color of the ink, the amount of the individual ink furnished by an anilox roller which has the same volume of cell for ink for different colors may be in excess or in shortage, making it difficult to have a balance in the colors on the print. As a result the finish in the color is often not beautiful. The keyless ink furnishing device used for multicolor printing uses, therefore, an anilox roller which has a different volume in the cell according to a physical properties, especially fluidity, of the ink used in the anilox roller. The processes of making the cell and the control of wear of the cell in use must be, therefore, under strict supervision, and these conditions make the running cost of a multicolor rotary printing machine much higher than that of a moncolor rotary printing machine.

BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to provide a plurality of inking rollers used for a multicolor

rotary printing machine which have on their outer circumferential surfaces minute hollow bodies. The individual rollers have a proper and different constitution according to the ink furnished to the roller in order to give a print which has a balance in the printed colors.

Another object of the invention is to raise the work efficiency of printing by providing a long-life inking roller.

A multicolor rotary printing machine according to the present invention is provided with a plurality of inking rollers each of which has on its surface an ink receiving layer. On the ink receiving layer minute hollow bodies are dispersed and mixed, and the minute hollow bodies located on the outer circumferential surface are opened. The minute hollow bodies placed on the individual rollers are suitable for the fluidity of the ink used on each inking roller. The minute hollow bodies are dispersed and mixed in the ratio of mixing which corresponds to the fluidity of the ink or the size of the minute hollow body is changed in order to be suitable for the ink. The ink receiving layer of the inking roller can be constituted as a layer in which the minute hollow bodies and hard material powder are dispersed and mixed.

The multicolor printing method of the present invention is carried out by employing a multicolor rotary printing machine.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view of an example of an ink furnishing device which can be applied to the multicolor rotary printing machine according to the invention,

Fig. 2 is a schematic view of a satellite type multicolor offset rotary printing machine which employs the ink furnishing device in Fig. 1,

Fig. 3, Fig. 4, and Fig. 5 are the drawings to explain the inking roller which is used in the invention,

Fig. 6 and Fig. 8 show embodiments of the invention in which the ink removal device in the ink furnishing device of Fig. 1 is replaced by another device,

Fig. 7 is a schematic view of an embodiment which used a fountain roller also used as the roller in the ink removal device shown in Fig. 8,

Fig. 9 and Fig. 10 are schematic views of a multicolor offset rotary printing machine of B-B stacking type which uses the ink furnishing device shown in Fig. 1,

Fig. 11 is a schematic view of a multicolor offset rotary printing machine of B-B laterally arranged type which uses the ink furnishing device shown in Fig. 1,

Fig. 12 through Fig. 33 show various embodiments of ink furnishing device which can be used for multicolor rotary printing machine according to the invention,

Fig. 15 is the embodiment of the invention identical to the embodiment of Fig. 1, and

Fig. 34 is a table which shows relation between Ink film thickness (μ) on paper and Richness of color on paper.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Embodiments of the present invention for the multicolor rotary printing machine and for the offset rotary printing machine which is used for the method of multicolor printing of the invention will be explained by the accompanying drawings.

In Fig. 1 a representative embodiment of the present invention is shown which is the ink furnishing device 01 for an offset rotary printing machine. The ink furnishing device 01 consists of an inking roller 1, ink removal device 2 which is in contact with the inking roller 1 and removes excessive ink from the outer circumferential surface of the inking roller 1, ink furnishing means 3 which lies upstream of the inking roller 1 and furnishes ink to the outer circumferential surface of the inking roller 1, and ink form roller 4 which is situated downstream of the inking roller 1 and the outer circumferential surface of which rotates in contact with both the outer circumferential surface of the inking roller 1 and the printing plate face on the plate cylinder P.

The inking roller 1 is provided with an ink receiving layer 11 which is constituted with a plurality of materials arranged on the surface of a main body member 16 made of, for instance, a steel stock. This ink receiving layer 11 has minute hollow bodies 12 uniformly dispersed and mixed on its surface and the minute hollow bodies 12 that are dispersed and mixed on the outer circumferential surface are open. In addition to the minute hollow bodies 12 a hard material powder 13 such as a hard inorganic powder is almost uniformly dispersed and mixed (see Fig. 4 and Fig. 5).

The ink receiving layer 11 is formed by an ink receiving layer substrate 14 and uniform layer on the substrate 14 in which the minute hollow bodies 12 are dispersed and mixed as shown in Fig. 4. Or as shown in Fig. 5 the uniform layer consists of the powder 13 of a hard material, minute hollow bodies 12, and ink receiving layer substrate 14.

As a material for the ink receiving layer substrate 14 a flexible material such as urethane resin is used in this embodiment. Other flexible materials in synthetic resin, other resins or rubber can be also used.

The minute hollow bodies 12 which are uni-

formly dispersed in the ink receiving layer substrate 14 should be those which form open sections in the ink receiving layer by having part of their shell removed. The minute hollow body 12 is generally called a microballoon, microsphere, hollow balloon, syntactic foam material, and hollow bodies of various materials are known such as carbon balloon, glass balloon, silica balloon, sirus bolloon, phenol balloon, vinylidene chloride balloon, alumina balloon, zirconia balloon. One or two examples will be mentioned, which include proprietary products such as 'Carbo Sphere' (registered) of VERSAR Manufacturing Inc. of U.S.A., and 'Fillite' (trade name) of Fillite Inc. of U.K. The former product is a carbon balloon, its bulk density being 0.15 g/cm^3 and the thickness of the body 1 - $2 \text{ }\mu\text{m}$, and there are four distributions of particle diameters ranging in $50 - 150 \text{ }\mu\text{m}$ (average diameter of $50 \text{ }\mu\text{m}$), $5 - 100 \text{ }\mu\text{m}$ (average diameter of $45 \text{ }\mu\text{m}$), $5 - 50 \text{ }\mu\text{m}$ (average diameter $60 \text{ }\mu\text{m}$). A minute hollow body the surface of which is coated with nickel, iron, copper, gold, etc. is known, and these coatings are effective. The last mentioned of the proprietary products is a silica balloon, its bulk density being 0.4 g/cm^3 , and the distribution of the particle diameters ranges in $30 - 300 \text{ }\mu\text{m}$.

In the present invention minute hollow bodies 12 in which particle diameters are in the range of $5 - 300 \text{ }\mu\text{m}$ are usable. It is easy to provide an inking roller which gives different amounts of ink supply to the plate by changing the ratio of mixture of minute hollow bodies 12 dispersed on the ink receiving layer 11 of the inking roller 1 or/and changing the size of the minute hollow body 12. The inking roller 1 which is capable of changing the amount of ink taken into the minute hollow bodies 12 dispersed and mixed on the outer circumferential surface of the inking roller 1 furnishes a proper amount of each color ink in multicolor printings where the supply of ink of different physical properties should be balanced in quantity. In the multicolor printing it is thereby easy to provide an ink furnishing device which can furnish a proper amount of color ink for each color in multicolor printing. This ink furnishing device can be effectively applied to a multicolor rotary printing machines of satellite type, B-B stacking type, B-B laterally arranged type, etc.

For a hard material powder 13 the powder of a ceramic material, metal, alloy, etc. can be used. The size of the particle in the hard inorganic material powder 13 should be at least $1 - 100 \text{ }\mu\text{m}$ in diameter when it is used in the present invention.

Next, the method of manufacture of an inking roller 1 will be explained below. At first, in an inking roller 1 in Fig. 4 minute hollow bodies 12 are uniformly dispersed on the substrate 14 of an ink receiving layer 11. In the inking roller 1 in Fig. 5 minute hollow bodies 12 and hard material powder

13 are uniformly dispersed in the substrate 14 of the ink receiving layer 11. This work process is carried out by a method as mixing or mulling that is suitable for the characteristics of the substrate 14 of the ink receiving layer 11. The substrate 14 of the ink receiving layer 11 thus obtained in which the minute hollow bodies 12 or both the minute hollow bodies 12 and powder of a hard material 13 are dispersed uniformly covers the surface of the main body member 16 to form an ink receiving layer 11. In this work process casting, wrapping, painting, or other suitable methods are used. Next, the ink receiving layer 11 covering the surface of the main body member is ground at the surface of the layer 11. The grinding is given by either a grinding machine or the friction between the inking roller 1 and the blade or bar after the inking roller 1 has been installed on the rotary printing machine. Then with the grinding in the ink receiving layer on which minute hollow bodies 12 are dispersed the minute hollow bodies 12 which are near the surface of the ink receiving layer 11 have part of the shell removed and expose the inner surface of the hollow body in the surface of the ink receiving layer 11 as shown in Fig. 4. Fig. 5 shows an ink receiving layer 11 on which minute hollow bodies 12 and hard material powder 13 are dispersed and part of the shell layer of a minute hollow body 12 located near the surface of the ink receiving layer 11 is removed and the inside of the shell exposed and open in the surface of the ink receiving layer and at the same time the hard material powder 13 are exposed at the surface of the ink receiving layer 11.

An ink removal device 2 is, in Fig. 1, comprises a blade 21 which is provided to make a contact with the outer circumferential surface of the inking roller 1. The ink furnishing means 3 comprises a fountain roller 31 which is provided upstream of the inking roller 1 and rotates with its outer circumferential surface a little apart from that of the inking roller 1 and an ink reservoir 32 which stores the ink with part of the fountain roller 31 immersed in the ink. And, the ink in the ink reservoir 32 receives additional ink during printing operation to overflow the ink in order to maintain a constant stored ink level as shown by the arrow mark in the figure.

Fig. 6, Fig. 7, Fig. 8 and Fig. 12 through Fig. 33 show the constitution of the ink furnishing device 01 used for various embodiments of the present invention that are related to the offset rotary printing machine.

In Fig. 6, Fig. 7, and Fig. 8 ink removal devices 2 are shown which are different in form from that in Fig. 1. This device 2 uses, in Fig. 6, a roller 22 in place of the blade 21, which has its outer circumferential surface in contact with the outer circumferential surface of the inking roller 1 and is either

rotated at a speed lower than the peripheral speed of the inking roller 1 or rotates at a speed almost the same as the peripheral speed of the inking roller 1 with a strengthened pressure of contact with the inking roller 1. In Fig. 7 an embodiment of the invention is shown in which a fountain roller 31 is also used as the roller 22 which is an ink removal member 2 in Fig. 8. In Fig. 8 a bar is used in place of the blade 21. This bar 23 has its one side in contact with the outer circumferential surface of the inking roller 1.

In Fig. 12 through Fig. 29 which will be explained below a blade 21 is used as an ink removal device 2, but in place of this blade a roller 22 or bar 23 can be used and the fountain roller 31 can be used additionally as an ink removal member 2.

In Fig. 12 through Fig. 33 the constitution of the embodiments of the present invention which combines an ink furnishing means 3 to the inking roller 1 with an ink supply route to the inking roller 1 or to the plate is shown. In Fig. 12 through Fig. 17 ink reservoir 32 in the shape of an ink pan or ink fountain to maintain the height of the ink storage always constant are shown. The ink reservoir 32 is required constituent of the ink furnishing means 3. Fig. 18 through Fig. 23 show ink discharge bodies 33 in the shape of nozzle, for instance, to discharge a specified volume of ink all the time. The ink discharge body 33 is also a required constituent of the ink furnishing device 3. In Fig. 24 through Fig. 32 ink storage bodies 34 and 35 in the shape of an ink pot or ink chamber, for instance, are provided to divide at least part of the open section of the ink storage body by part of the circumference of the inking roller 1 or fountain roller 31. Those ink storage bodies 34 and 35 are required constituents of the ink furnishing means 3. In Fig. 24 through Fig. 29 an ink storage body 34 which opens part of the open section is used, and in Fig. 18 through Fig. 21 an ink storage body 35 which closes the open section and at the same time has an ink removal device 2 added to itself is used. In Fig. 30 and Fig. 31 the ink removal device 2 which is installed with the ink storage body 35 consists of a blade 21 and in Fig. 32 and Fig. 33 the ink removal device 2 which is installed with the ink storage body 35 consists of a bar 23.

Further, in Fig. 12, Fig. 14, Fig. 16, Fig. 18, Fig. 20, Fig. 22, Fig. 23, Fig. 24, Fig. 26, Fig. 28, Fig. 30, Fig. 32 the inking roller 1 directly furnishes ink to the surface of a plate. Likewise in Fig. 13, Fig. 15, Fig. 17, Fig. 19, Fig. 21, Fig. 23, Fig. 25, Fig. 27, Fig. 29, Fig. 31, and Fig. 33 an ink form roller 4 intervenes between the inking roller 1 and the surface of a plate and the ink form roller 4 furnishes ink to the surface of the plate. And in Fig. 12, Fig. 13, Fig. 18, Fig. 19, Fig. 24, Fig. 25, Fig. 30, and Fig. 31 the ink reservoir 32 or ink dis-

charge body 33 or ink storage body 34 or 35 furnishes ink directly to the outer circumferential surface of the inking roller 1. Likewise in Fig. 14, Fig. 5, Fig. 6, Fig. 17, Fig. 20, Fig. 21, Fig. 22, Fig. 23, Fig. 26, Fig. 27, Fig. 28, Fig. 29, Fig. 32, and Fig. 33 the ink furnishing means 3 is provided with a fountain roller, and the ink is furnished to the outer circumferential surface of the inking roller 1 through the fountain roller 31 from the ink reservoir 32, or ink discharge body 33 or ink storage body 34 or 35. Further, in Fig. 14, Fig. 15, Fig. 20, Fig. 21, Fig. 26, Fig. 27, Fig. 32, and Fig. 33 the ink is directly furnished to the outer circumferential surface of the inking roller 1 from the fountain roller 31. In Fig. 16, Fig. 17, Fig. 22, Fig. 23, Fig. 28, and Fig. 29 a transfer roller 36 intervenes between the fountain roller 31 and inking roller 1, and this transfer roller 36 furnishes ink to the outer circumferential surface of the inking roller 1. In the fountain roller 31 in the foregoing description its outer circumferential surface can be either apart from or in contact with the outer circumferential surface of the inking roller 1. Further, in this embodiment an ink film thickness regulating blade 37 is provided near the outer circumferential surface of the fountain roller 31 and this blade limits the ink film thickness on the outer circumferential surface of the fountain roller 31 and the ink is furnished to the outer circumferential surface of the inking roller 1 through the transfer roller 36. The transfer roller 36 is, therefore, in contact with both the circumferential surface of the fountain roller 31 and the circumferential surface of the inking roller 1, and the outer circumferential surface of the inking roller 31 is not furnished excessive ink. But on the outer circumferential surface of the inking roller 1 after it has run on the outer circumferential surface of the ink from roller 4, there is ink which was not used because it did not contact images or lines on the plate, that is, residual ink is left or transferred. The blade 21 which is a member of the ink removal device 2 is provided to remove such residual ink. The D in the figures is a wetting water furnishing device, and Fig. 12 through Fig. 33 show only a wetting form roller to simplify the figure.

The above mentioned embodiments of the invention are all applicable to the offset rotary printing machine, and they can be applied to the letterpress rotary printing machine as well.

In those embodiments an ink furnishing means 3 transfers ink to the outer circumferential surface of the inking roller 1 by the mutual contact of the means 3 and the roller 1.

When the ink furnishing device 3 is provided with an ink reservoir 32, at least part of the inking roller or a fountain roller 31 is immersed in the ink in the ink reservoir 32. The ink which is pumped up by the outer circumferential surface of the fountain

roller 31 is furnished from its outer circumferential surface directly or through the outer circumferential surface of a transfer roller 36 to the outer circumferential surface of the inking roller 1. When the ink furnishing means 3 is provided with an ink discharge body 33 the ink is discharged from the ink discharge body 33 to the outer circumferential surface of the inking roller 1. Or, the ink is discharged toward a section close to both fountain roller 31 and inking roller 1 or the contact section of those rollers 31 and 1. In other case the ink is discharged toward the outer circumferential surface of the fountain roller 31 and then the ink is furnished directly or through the outer circumferential surface of the fountain roller 31 or through the outer circumferential surface of a transfer roller 36 to the outer circumferential surface of the inking roller 1. When the ink furnishing means 3 has an open section and is provided with an ink storage body 34 or 35 which divides at least part of the open section by part of the inking roller 1 or fountain roller 31, the ink is furnished directly or from the outer circumferential surface of the fountain roller 31 which divides the ink storage body 34 or through the outer circumferential surface of the transfer roller 36 to the outer circumferential surface of the inking roller 1 which divides the open section of the ink storage body 34 or 35.

Part of the ink furnished to the inking roller 1 is taken in the hollow sections of the minute hollow bodies 12 which are dispersed and mixed with their hollow sections opened at the outer circumferential surface of the inking roller 1.

Next, the ink removal device 2 which is in contact with the outer circumferential surface of the inking roller 1 by the rotation of the inking roller 1. After the removal of the excessive ink the ink is taken in the hollow sections of the minute hollow bodies 12 which play the role of an ink retaining cell and the quantity of the ink in the hollow sections is the proper quantity for printing.

On the other hand in Fig. 16, Fig. 17, Fig. 22, Fig. 23, Fig. 28 and Fig. 29 there is no excessive ink on the outer circumferential surface of the inking roller 1 because the ink the quantity of which is adjusted to the proper quantity required for printing by the ink furnishing means 3 is furnished to the hollow sections of the minute hollow bodies 12 on the outer circumferential surface of the inking roller, and there is no need for the removal of the excessive ink.

By further rotation of the inking roller 1 the ink of a proper quantity for printing that is in the hollow sections of the minute hollow bodies on the outer circumferential surface of the inking roller 1 is furnished directly from the inking roller 1 or through the outer circumferential surface of the ink form roller 4 to the surface of a plate.

On the outer circumferential surface of the inking roller 1 from which the furnishing of the ink directly or through the outer circumferential surface of the ink form roller 4 to the surface of a plate was finished the ink that is left by no contact with the images and lines on the plate, namely surplus ink remains or has been transferred. In Fig. 1, Fig. 6, Fig. 7, Fig. 8, Fig. 12 through Fig. 15, Fig. 18 through Fig. 21, Fig. 24 through Fig. 27, Fig. 30 through Fig. 33 the ink is furnished to cover the surplus ink and the surplus ink is removed by the ink removal device 2 to provide a proper quantity of ink on the outer circumferential surface of the inking roller 1, but in Fig. 16, Fig. 17, Fig. 22, Fig. 23, Fig. 28, and Fig. 29 if ink is furnished on the surplus ink, a section where excessive ink is furnished develops on the outer circumferential surface of the inking roller 1. Accordingly in Fig. 16, Fig. 17, Fig. 22, Fig. 23, Fig. 28, and Fig. 29 the blade which is an ink removal device 2 is made to contact with the inking roller 1 which has finished with furnishing ink to the face of the plate in order to remove the surplus ink from the outer circumferential surface of the inking roller 1.

With the continued rotation of the inking roller 1 the above described actions proceed continuously.

On the other hand, the outer circumferential surface of the inking roller 1 is gradually worn while the excessive ink or surplus ink is removed by the ink removal device 2, but in the ink receiving layer 11 provided on the surface of the inking roller 1 minute hollow bodies 12 are dispersed and mixed in substantially uniformly, and those bodies 12 are exposed successively at the circumferential surface and then they open their hollow sections so that the outer circumferential state of the inking roller 1 does not change significantly until the time just before the ink receiving layer 11 is worn out. Accordingly a proper quantity of ink for the printing continues to be furnished to the plate for a long period.

Furthermore, if the inking roller 1 is used which is constituted with the ink receiving layer 11 in which the powder 13 of a hard material, for instance, hard inorganic material is mixed, the friction with the ink removal device 2 during the ink removal action is carried by the hard inorganic powder so that the wear of the outer circumferential surface of the inking roller 1 is suppressed. Further, even in this case the state of the outer circumferential surface of the inking roller 1 does not make a significant change until just before the ink receiving layer 11 is worn out. Accordingly it is possible to continue to furnish a proper quantity of ink for a long period.

The ink furnishing device 01 which was explained in the foregoing description is used for the

multicolor rotary printing machine and multicolor printing method. A schematic view of a satellite type multicolor offset rotary printing machine which employs an ink furnishing device shown in Fig. 1 is seen in Fig. 2. The schematic view of a B-B stacking type multicolor offset rotary printing machine which employs the ink furnishing device of Fig. 1 is shown in Fig. 9 and Fig. 10. Further, the schematic view of a multicolor offset rotary printing machine of B-B laterally arranged type which employs the ink furnishing device of Fig. 1 is shown in Fig. 11.

The ink furnishing device 01 which is provided with an inking roller 1 which has on its surface the ink receiving layer 11 on which minute hollow bodies 12 with a suitable size or and mixing ratio suitable for at least fluidity in the physical properties of the ink are dispersed and mixed in and the hollow sections of minute hollow bodies 12 opened on the outer circumferential surface is successively used to carry out multicolor printing. Not all the ink furnishing devices should be of the same form. For instance, the constitution of the ink furnishing means can be changed by the color of ink or by the position of installation on the rotary printing machine.

The ratio of mixing or and size of the minute hollow bodies 12 used on the inking roller 1 is usually changed with a consideration given to the fluidity of ink and the relation between the ink film thickness and reflective color richness (hereinafter called color richness by film thickness). Only the size of the minute hollow body 12 or only the ratio of mixing of the minute hollow body 12 or both the size and ratio of mixing of the minute hollow bodies can be changed. In most cases the fluidity and color richness by film thickness of ink are different by ink. With the ink of a low fluidity with difficulty in flowing as far as fluidity is concerned, the ratio of mixing of minute hollow bodies 12 has to be increased or/and the size of the minute hollow body 12 has to be made larger. As far as the color richness by film thickness is concerned, balanced color richness by film thickness on the palte is required if ink in a number of color is used simultaneously. For this balance it is necessary to change the film thickness, that is to change the quantity of furnished ink by changing the ratio of mixing or/and the size of the minute hollow bodies 12.

In the printing which is carried out by the keyless furnishing ink using cells or minute hollow bodies (both cells and minute hollow bodies are represented by one phrase 'minute cells, etc.'), a certain quantity of ink corresponding to the total volume of many minute cells, etc. is furnished all the time to the surface of a plate for its printing. A certain required quantity of ink has to be, therefore, received regularly in the minute cells, etc. all the

time. If the surfaces of minute cells, etc. have substantially a constant wetting (if the material which constitutes the minute cells, etc. is almost fixed and the states of the surfaces of the minute cells, etc. are substantially the same, the wetting is considered to be constant.), the easiness of the flow of ink into the small cell is related to the fluidity of the ink. The fluidity of ink is, however, different with the ink according to the measurement by the applicant of the invention which shows that the fluidity (glass palte, 10 minutes, temperature 25° C, flow extension mm) of yellow was 194, that of magenda 256, that of cyanide 246, and that of black 29s.

It is, therefore, necessary to make the volume of a small cell large for ink for low fluidity in order to furnish a certain quantity of ink for each ink when the volume of the cell is to be related to the fluidity of the ink.

On the other hand the printing which is made with the keyless ink furnishing which uses minute cells, etc. requires a certain quantity of ink on the plate, and the richness of color by film thickness for each ink in the print is different according to the measurement by the applicant of the invention as shown in Fig. 34. If a number of inks of different colors are used for printing, the print should have a balance in the richnesses of color by film thickness for the colors on the print, and in order to achieve the balance, the thickness of film should be different by the ink, that is, the quantity of furnished ink should be varied. This means that the volumes of minute cells, etc. should be different.

The ink for printing is a mixture of a pigment and liquid. For the ink of almost the same color the fluidity and richness of color by film thickness change independently by the difference in the pigment or liquid or/and the difference in the ratios of their mixing. It is, therefore, necessary to select an inking roller to be used for each ink.

It goes without saying that the fluidity and richness of color by film thickness of each ink are mutually independent factors in changing the cell volume, and the cell volume should be finally determined by considering both factors.

According to the present invention as described above, a multicolor rotary printing machine which is capable of furnishing a proper quantity of ink according to its physical property and method of multicolor printing which is used in the multicolor printing machine of the invention can be provided. And, the ink furnishing device used in multicolor rotary printing machines of present invention can be effectively used for multicolor rotary printing machines of satellite type, B-B stacking type, B-B laterally arranged type or other types.

In the keyless ink furnishing device used in the embodiments of the present invention, if the inking

roller with which an ink removal member is in contact and to which the ink removal member works wears, the outer circumferential surface of the inking roller develops no significant change and the inking roller can be used for a long term, making the frequency of replacing the inking roller small and raising the efficiency of the printing work. Furthermore, when the powder of a hard material is dispersed and mixed in the ink receiving layer, the powder which is exposed on the surface of the receiving layer carries the load from a doctor blade so that the wear in the ink receiving layer is suppressed to give a longer life of the inking roller.

By the way since the inking roller is less expensive than the anilox roller which is conventionally used and the frequency of replacing the inking roller is less, the running cost of multicolor rotary printing machines according to the present invention is much reduced.

Claims

1. A multicolor rotary printing machine provided with a plurality of ink furnishing devices, said ink furnishing device comprising an inking roller provided on its surface with an ink receiving layer which has minute hollow bodies dispersed and mixed on its surface and having the open sections of said minute hollow bodies positioned on the outer circumferential surface of said inking roller, and said minute hollow bodies on said inking roller being dispersed and mixed in a mixing ratio related to at least the fluidity in the physical properties of ink being used.

2. A multicolor rotary printing machine provided with a plurality of ink furnishing devices, said ink furnishing device comprising an inking roller provided on its surface with an ink receiving layer which has the powder of a hard material and minute hollow bodies dispersed and mixed on its surface and having the open sections of said minute hollow bodies positioned on the outer circumferential surface of said inking roller, and said minute hollow bodies on said inking roller being dispersed and mixed in a mixing ratio related to at least the fluidity in the physical properties of ink being used.

3. A multicolor rotary printing machine provided with a plurality of ink furnishing devices, said ink furnishing device comprising an inking roller provided on its surface with an ink receiving layer which has minute hollow bodies dispersed and mixed on its surface and having the open sections of said minute hollow bodies positioned on the outer circumferential surface of said inking roller, and said minute hollow bodies on said inking roller having a size related to at least the fluidity in the physical properties of ink being used.

4. A multicolor rotary printing machine provided with a plurality of ink furnishing devices, said ink furnishing device comprising an inking roller provided on its surface with an ink receiving layer which has the powder of a hard material and minute hollow bodies dispersed and mixed on its surface and having the open sections of said minute hollow bodies positioned on the outer circumferential surface of said inking roller, and said minute hollow bodies on said inking roller having a size related to at least the fluidity in the physical properties of ink being used.

5. A multicolor rotary printing machine provided with a plurality of ink furnishing devices, said ink furnishing device comprising an inking roller provided on its surface with an ink receiving layer which has minute hollow bodies dispersed and mixed on its surface and having the open sections of said minute hollow bodies positioned on the outer circumferential surface of said inking roller, and said minute hollow bodies on said inking roller being dispersed and mixed in a size and ratio related to at least the fluidity in the physical properties of ink being used.

6. A multicolor rotary printing machine provided with a plurality of ink furnishing devices, said ink furnishing device comprising an inking roller provided on its surface with an ink receiving layer which has the powder of a hard material and minute hollow bodies dispersed and mixed on its surface and having the open sections of said minute hollow bodies positioned on the outer circumferential surface of said inking roller, and said minute hollow bodies on said inking roller being dispersed in a size and ratio related to at least the fluidity in the physical properties of ink being used.

7. A method for multicolor printing characterized in that said multicolor printing employs a plurality of inking rollers successively, said inking roller being provided on its surface with an ink receiving layer on which minute hollow bodies in a ratio related to at least the fluidity in the physical properties of ink being used are dispersed and mixed and having the open sections of said minute hollow bodies positioned on the outer circumferential surface of said inking roller.

8. A method for multicolor printing characterized in that said multicolor printing employs a plurality of inking rollers successively, said inking roller being provided on its surface with an ink receiving layer on which minute hollow bodies of a size related to at least the fluidity in the physical properties of ink being used are dispersed and mixed and having the open sections of said minute hollow bodies positioned on the outer circumferential surface of said inking roller.

9. A method for multicolor printing characterized in that said multicolor printing employs a plural-

ity of inking rollers successively, said inking roller being provided on its surface with an ink receiving layer on which minute hollow bodies of a size and ratio related to at least the fluidity in the physical properties of ink being used are dispersed and mixed and having the open sections of said minute hollow bodies positioned on the outer circumferential surface of said inking roller.

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FIG. 1

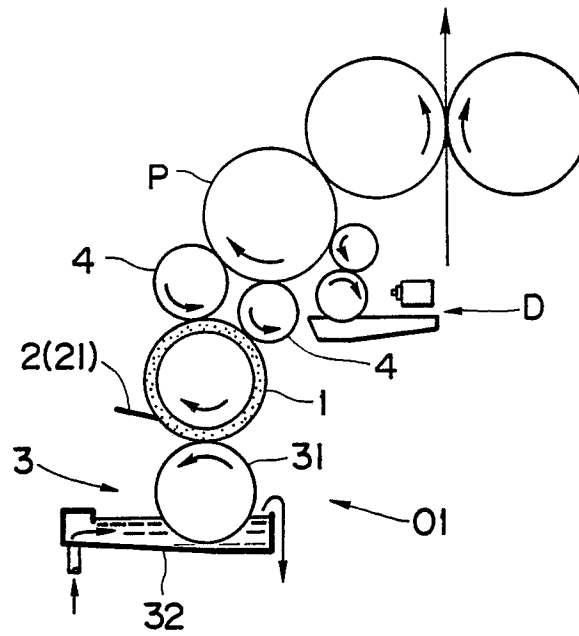


FIG. 2

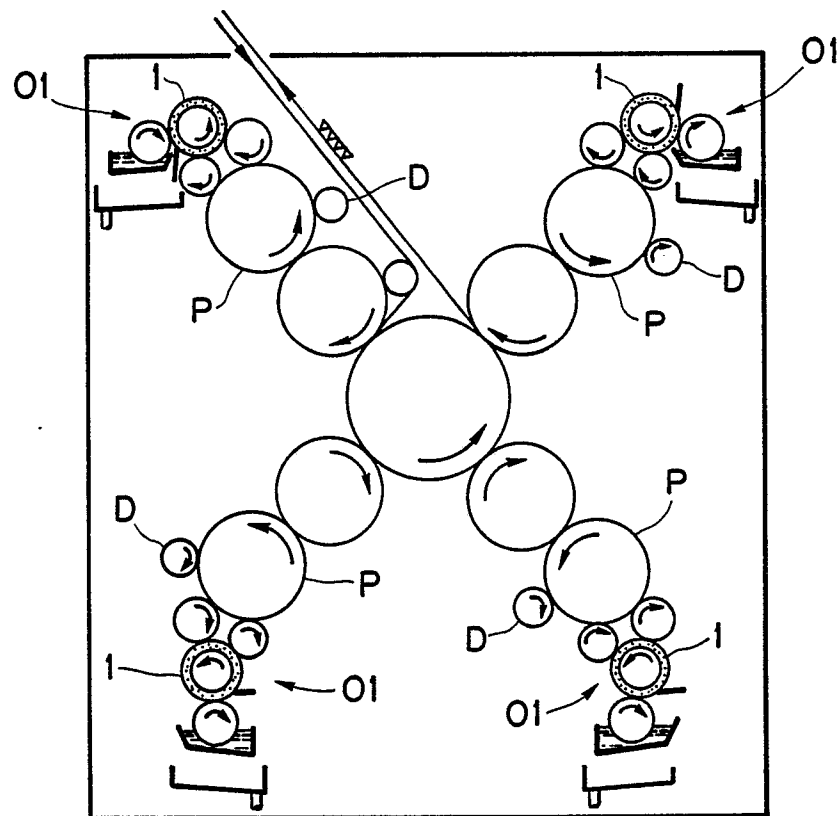


FIG. 3

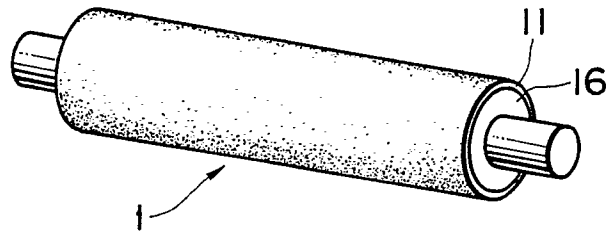


FIG. 4

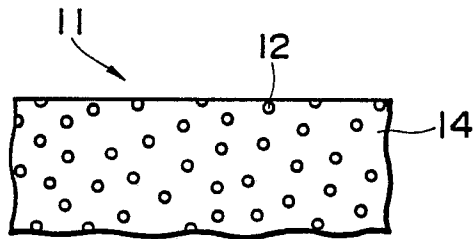


FIG. 5

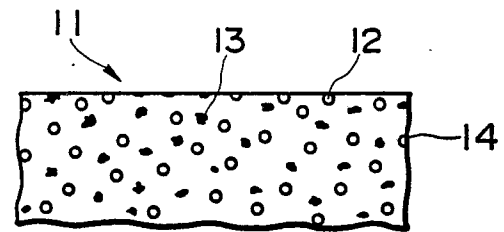


FIG. 6

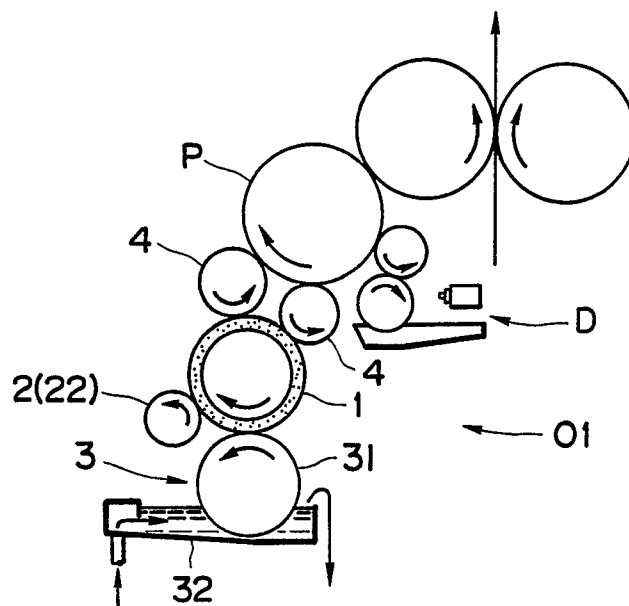


FIG. 7

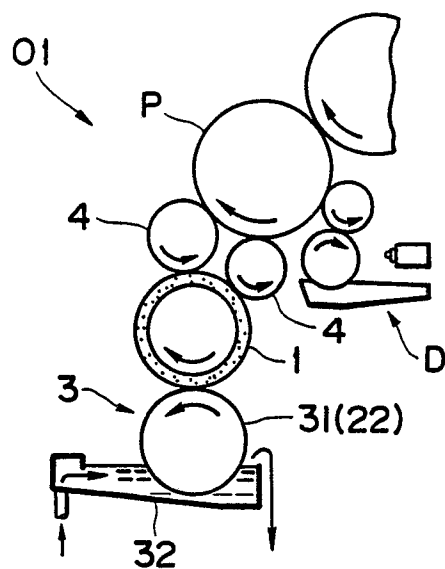


FIG. 8

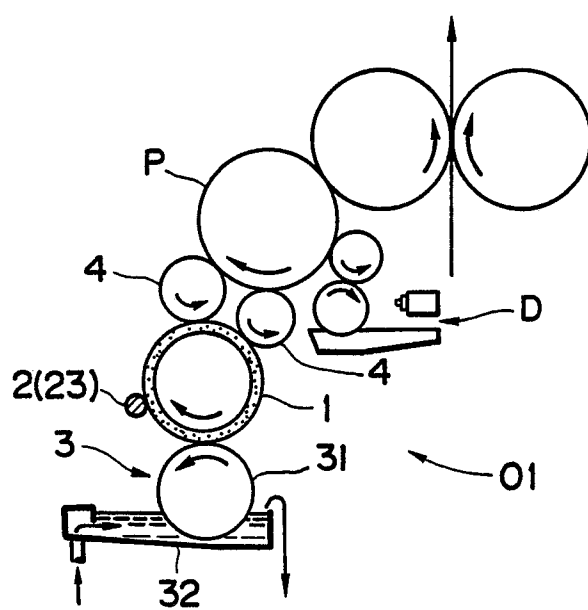


FIG. 9

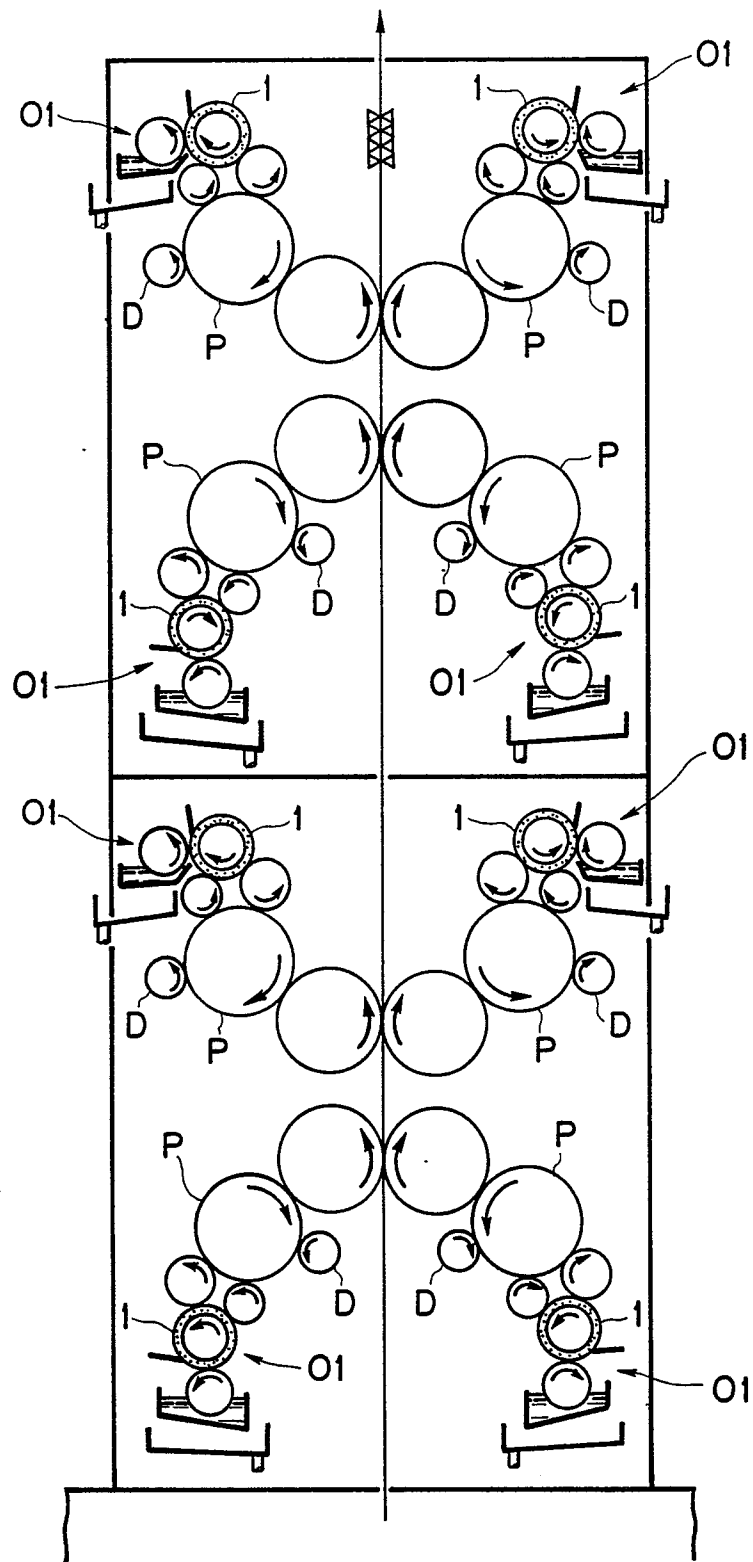


FIG. 10

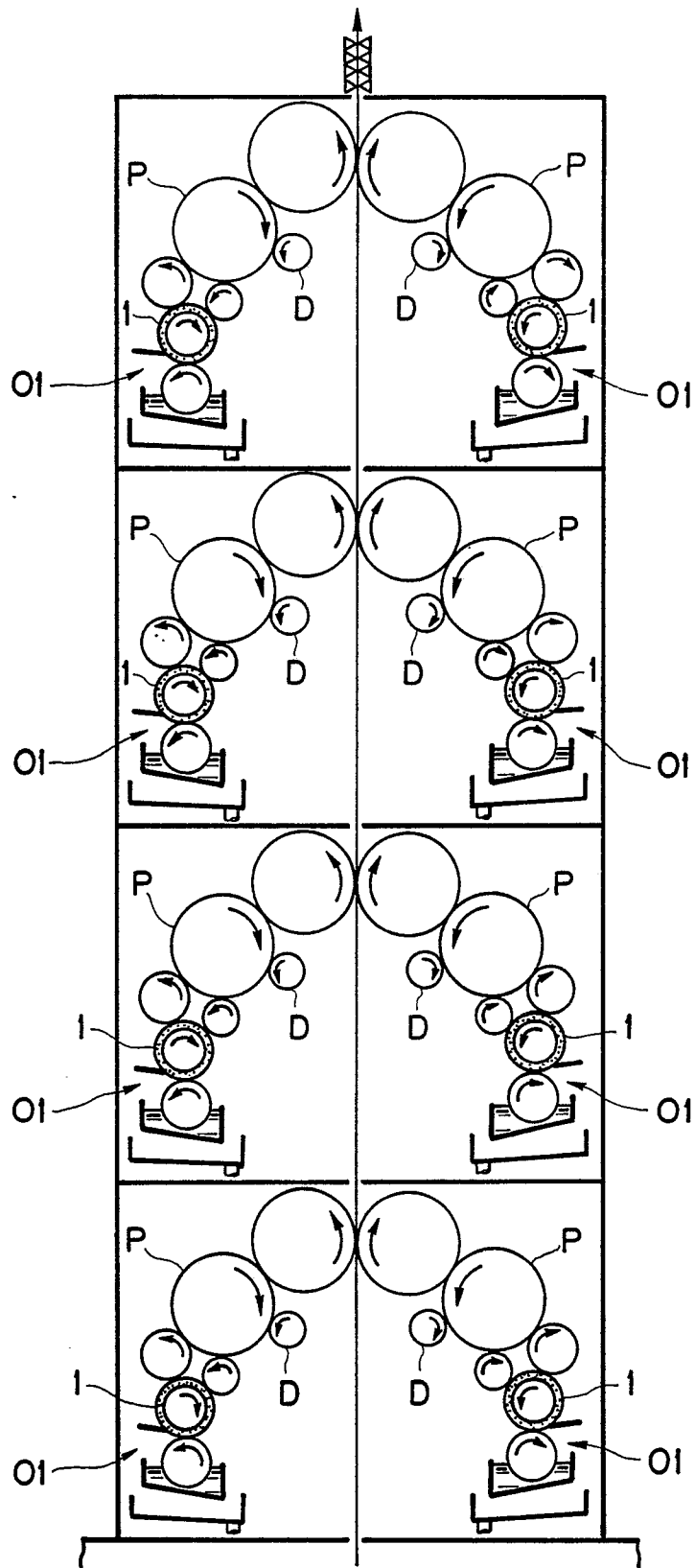


FIG. 11

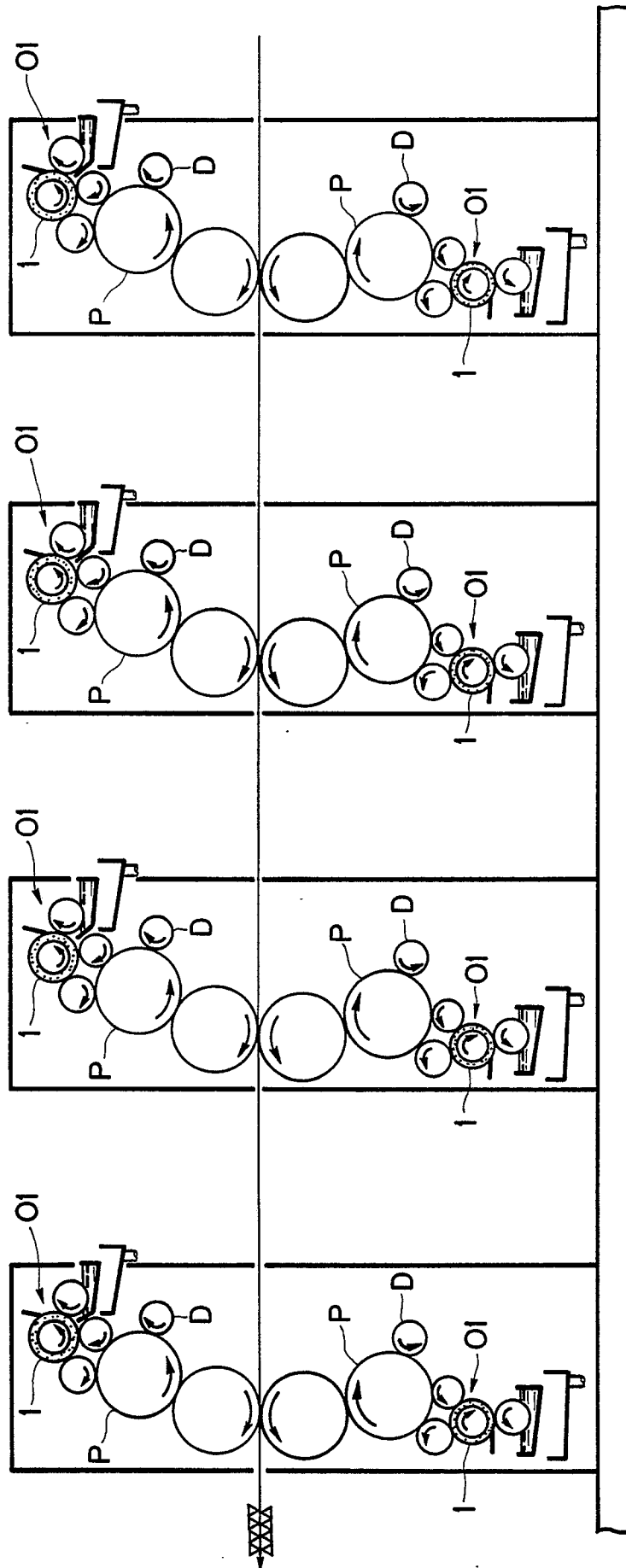


FIG. 12

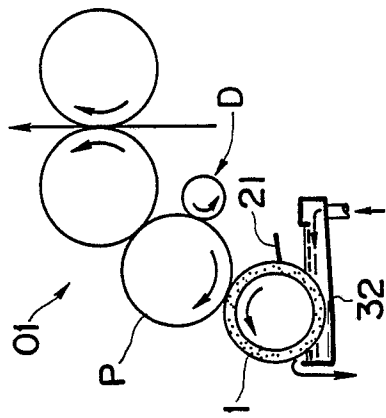


FIG. 13

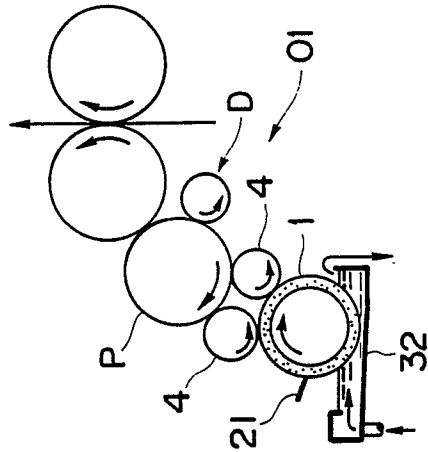


FIG. 14.

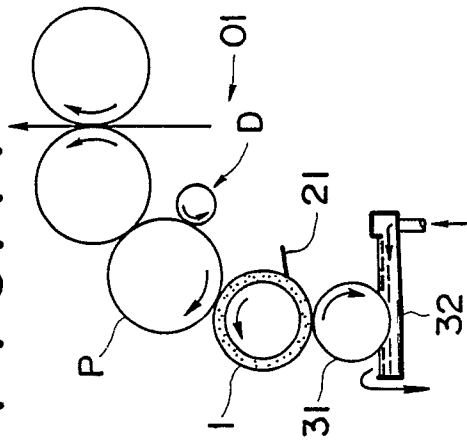


Fig. 15.

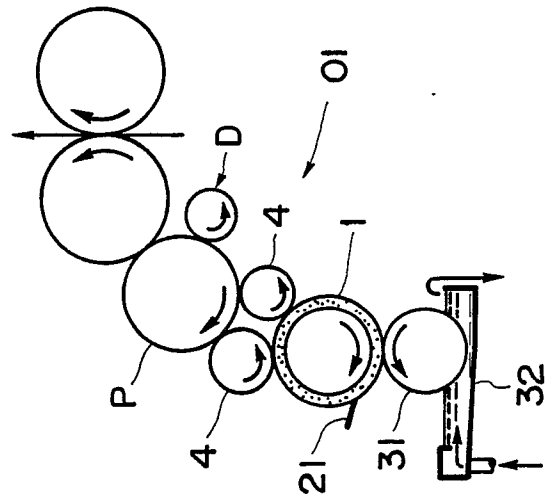


FIG. 16

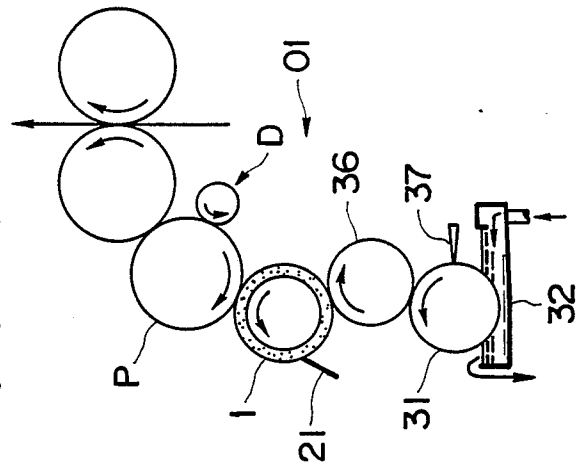


FIG. 17

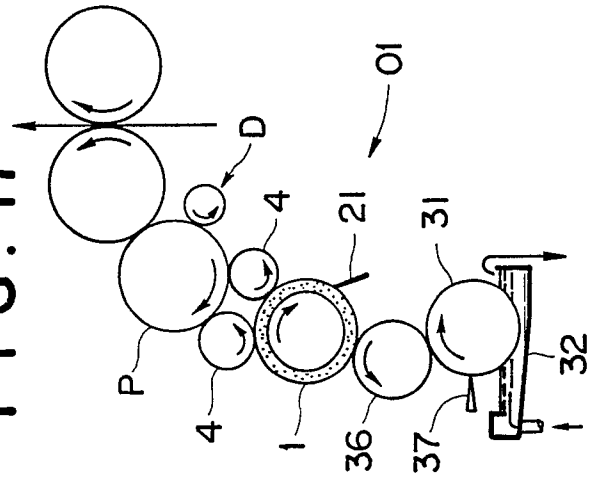


FIG. 18

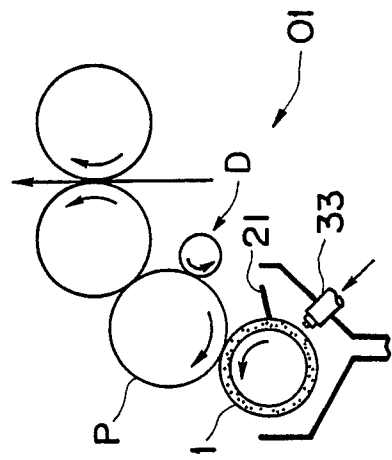


FIG. 19

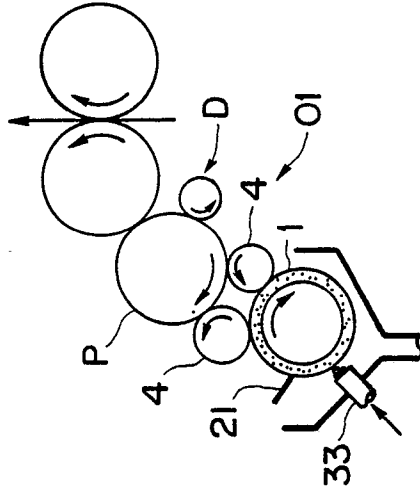


FIG. 20

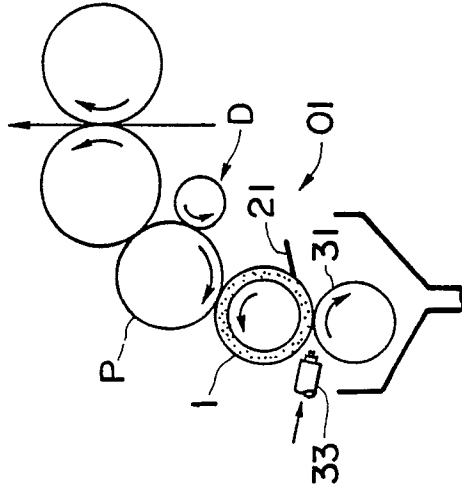


FIG. 21

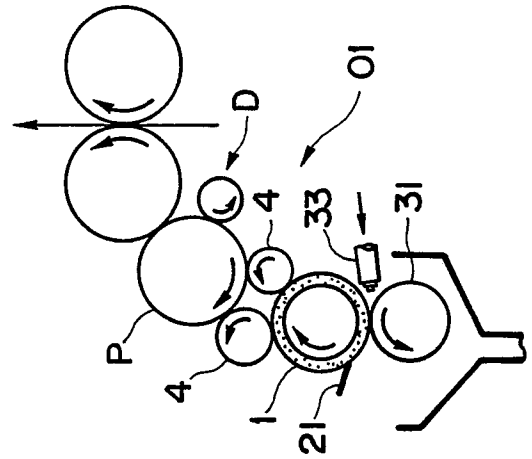


FIG. 22

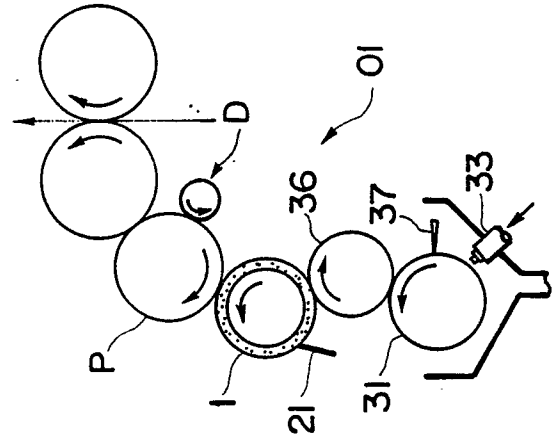


FIG. 23

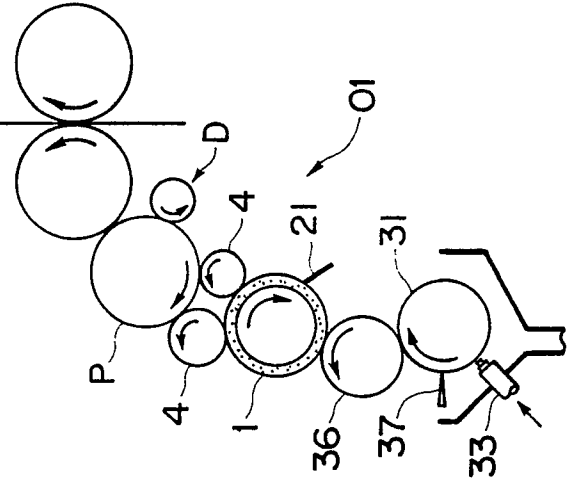


FIG. 24

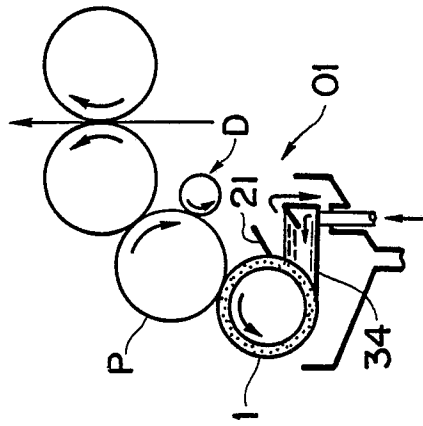


FIG. 25

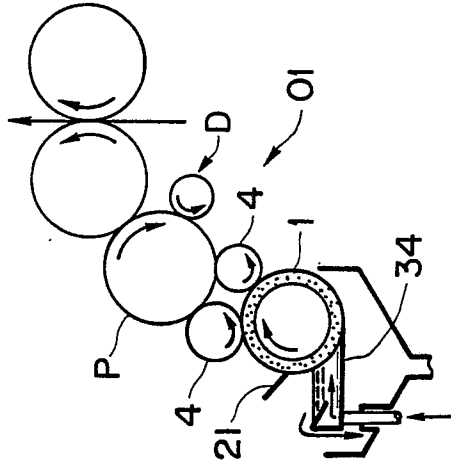


FIG. 26

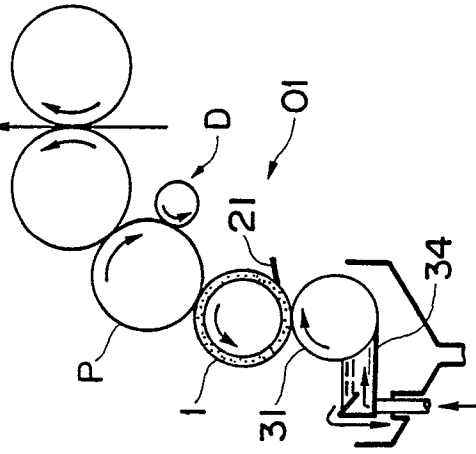


FIG. 27

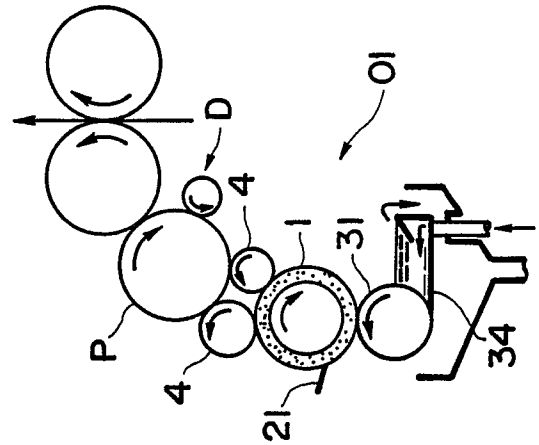


FIG. 28

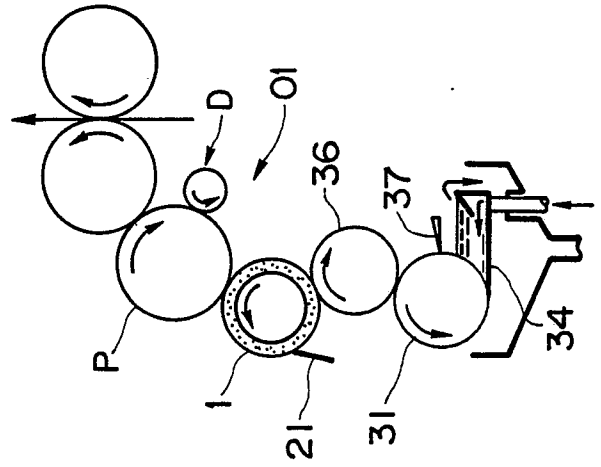


FIG. 29

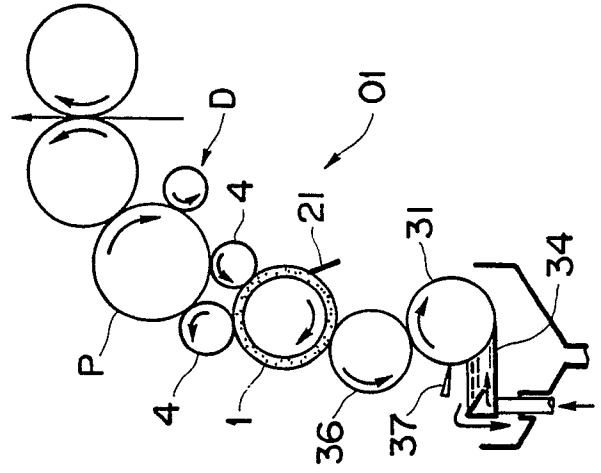


FIG. 30

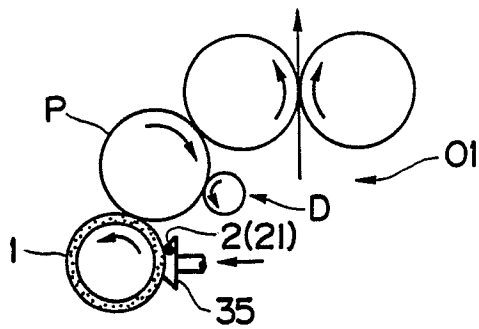


FIG. 31

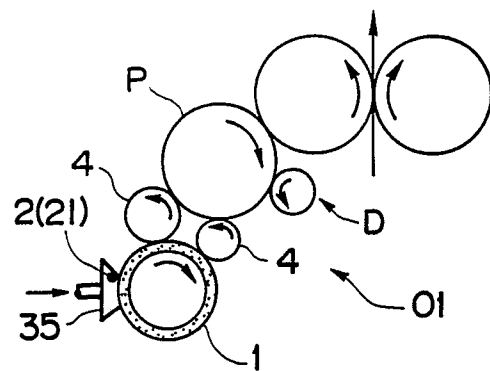


FIG. 32

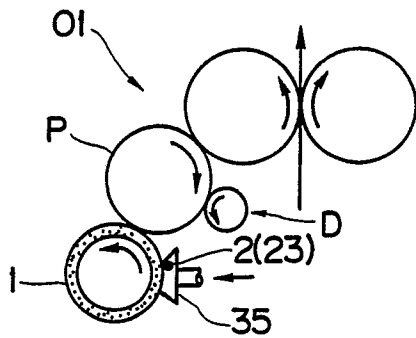


FIG. 33

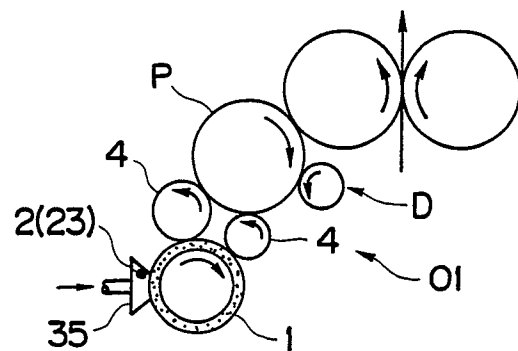


FIG. 34

