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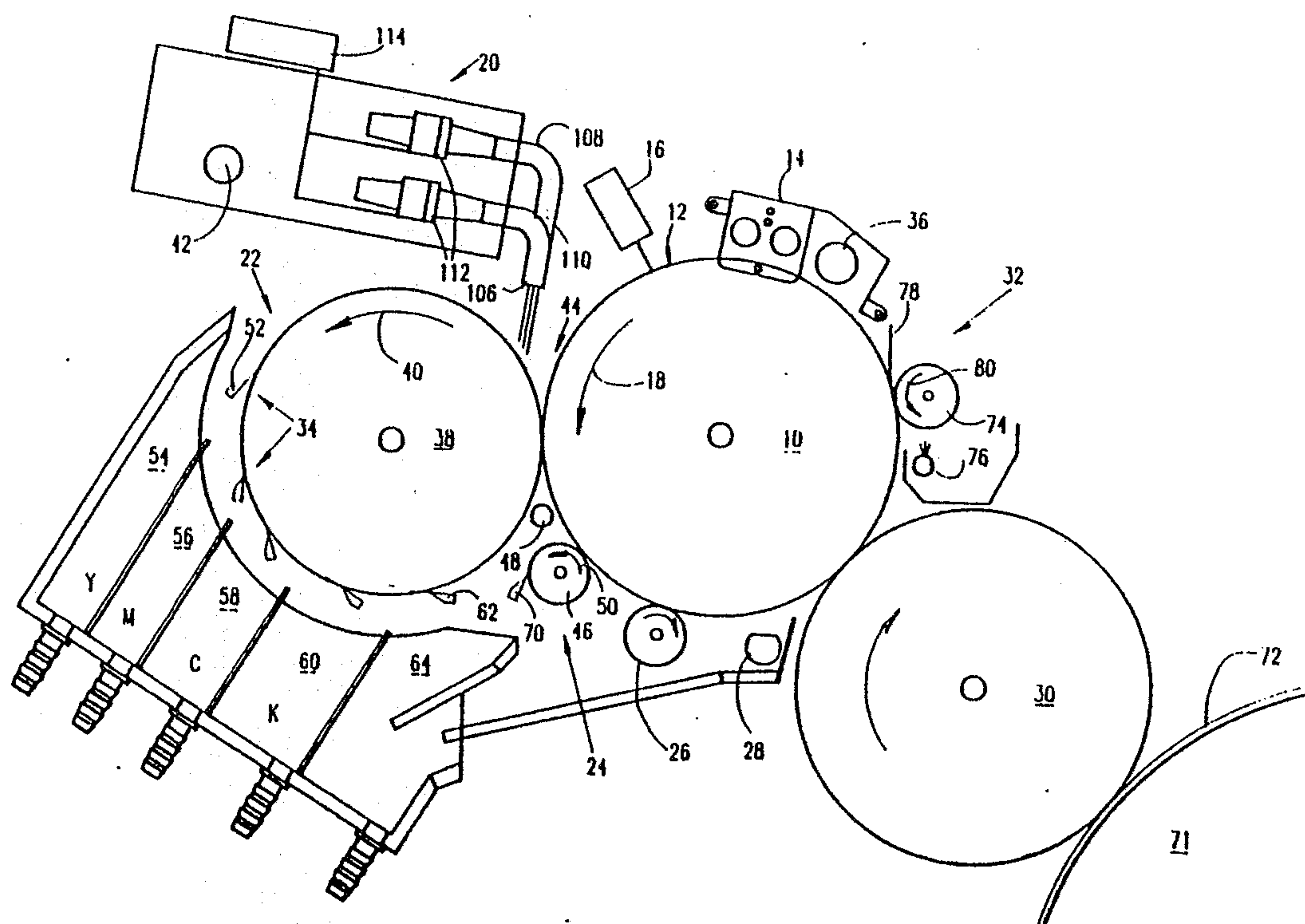
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(54) Title: LIQUID DEVELOPER IMAGING SYSTEM

(57) Abstract

Imaging apparatus having an image forming surface (12) arranged for movement in a first direction and an image forming apparatus (16) for forming electrostatic latent image and background areas at respective first and second electrical potentials on the image forming surface (12), development apparatus (22) for developing the electrostatic latent image using a liquid developer including electrically charged toner particles to form a developed image, the development apparatus (22) comprising a development surface (38) maintained in a spaced apart relationship from the image forming surface (12) and moving in a direction opposite to the first direction, an additional surface (46) spaced from the image forming surface (12) for the removal of toner particles from the background areas and preferably moving in a direction opposite to the first direction, and apparatus (48) for supplying a liquid to at least a portion of the space between the image forming surface (12) and the additional surface (48).



LIQUID DEVELOPER IMAGING SYSTEM**FIELD OF THE INVENTION**

The present invention relates generally to color electrostatic imaging and particularly to apparatus for developing color electrostatic images.

BACKGROUND OF THE INVENTION

Systems for color liquid toner electrostatic image reproduction are known in the art. These systems comprise apparatus for creating a latent electrostatic image on a surface through the formation of image and background areas, apparatus for developing the latent image including contacting the latent image with a liquid toner and a background cleanup apparatus that minimizes the undesirable deposition of toner on background surfaces. The development systems described in PCT patent application WO 90/14619 employ a reverse roller as a development surface with the reverse roller voltage intermediate the voltages on the image and background regions of the latent image bearing surface. For the systems described therein the background downstream of the development roller is virtually free of carrier liquid. Other systems which do not use rollers as a development surface, such as those described in U.S. Patent 4,420,244, use a reverse roller charged to a voltage intermediate the voltage on image and background areas of the surface for removal of toner particles and excess liquid from the background and for the metering of the image.

SUMMARY OF THE INVENTION

There is provided in accordance with the present invention imaging apparatus having an image forming surface arranged for movement in a first direction and an image forming apparatus for forming electrostatic latent image and background areas at respective first and second electrical potentials on the image forming surface, development apparatus for developing the electrostatic latent image using a liquid developer including electrically charged toner particles to form a developed image, the development apparatus comprising a development surface maintained in a spaced apart relationship from the image forming surface and moving in a direction opposite to the first direction, an

1 additional surface spaced from the image forming surface for
2 the removal of toner particles from the background areas and
3 preferably moving in a direction opposite to the first
4 direction, and apparatus for supplying a liquid to at least
5 a portion of the space between the image forming surface and
6 the additional surface.

7 Alternatively, in a preferred embodiment of the
8 invention, the additional surface moves in the first
9 direction.

10 In accordance with a preferred embodiment of the
11 invention the development surface and the additional
12 surface are charged to respective third and fourth
13 electrical potentials which are preferably different from
14 each other and which are intermediate the first and second
15 electrical potentials.

16 In accordance with a preferred embodiment of the
17 invention the fourth electrical potential is closer to the
18 value of the first electrical potential than is the third
19 electrical potential.

20 In accordance with still another preferred embodiment
21 of the invention the image forming surface is a surface of a
22 drum rotating about an axis.

23 In accordance with yet another preferred embodiment of
24 the invention the development surface is the surface of a
25 rotating roller having an axis of rotation perpendicular to
26 the first direction.

27 In accordance with a further preferred embodiment
28 of the invention the additional surface is a surface of a
29 rotating roller having an axis of rotation perpendicular to
30 the first direction.

31 In accordance with another preferred embodiment
32 of the invention the development surface is the surface of
33 a rotating roller having an axis parallel to the axis of the
34 drum and wherein the rotating roller and rotating drum
35 rotate in the same sense.

36 In accordance with yet a further preferred embodiment
37 of the invention the additional surface is the surface of a
38 rotating roller having an axis parallel to the axis of the
39 drum and wherein the rotating roller and rotating drum

1 rotate in the same sense.

2 In accordance with yet a further preferred embodiment
3 of the invention the additional surface is the surface of a
4 rotating roller having an axis parallel to the axis of the
5 drum and wherein the rotating roller and rotating drum
6 rotate in opposite senses.

7 In accordance with yet a further preferred embodiment
8 of the invention a portion of the additional surface is
9 closely spaced from the image forming surface and the
10 portion moves in a direction which is opposite to the
11 first direction.

12 BRIEF DESCRIPTION OF THE DRAWINGS

13 The present invention will be more fully understood and
14 appreciated from the following detailed description, taken
15 in conjunction with the drawings in which:

16 Fig. 1 is a generalized schematic illustration of an
17 imaging system constructed and operative in accordance with
18 a preferred embodiment of the present invention;

19 Fig. 2 is a schematic illustration of a portion of the
20 apparatus of Fig. 1;

21 Fig. 3 is a front perspective illustration of a
22 pivotable multicolor liquid developer spray assembly;

23 Fig. 4 is a side perspective illustration of the
24 background cleaning station;

25 Fig. 5 is a schematic illustration of a portion of an
26 alternative preferred embodiment of the invention; and

27 Fig. 6 is a schematic illustration of a portion of
28 another alternative preferred embodiment of the invention;

29 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

30 Reference is now made to Figs. 1 and 2 which illustrate
31 a multicolor electrostatic imaging system constructed and
32 operative in accordance with a preferred embodiment of the
33 present invention. As seen in Figs. 1 and 2 there is
34 provided an image bearing surface 12 typically embodied in a
35 rotating photoconductive drum 10. Drum 10 is driven in any
36 appropriate manner (not shown) in the direction of arrow 18
37 past charging apparatus 14, preferably a corotron, adapted
38 to charge the surface of the photoconductive drum 10. The
39 image to be reproduced is focused by imaging apparatus 16

1 upon the charged surface 12 at least partially discharging
2 the photoconductor in the areas struck by light and forming
3 the electrostatic latent image. Thus the latent image
4 normally includes image areas at a first electrical
5 potential and background areas at another electrical
6 potential.

7 Photoconductive Drum 10 and photoconductor charging
8 apparatus 14 may be any suitable drum and charging apparatus
9 such as are well known in the art.

10 Imaging apparatus 16 may be a modulated laser beam
11 scanning apparatus, an optical focusing device for imaging a
12 copy on a drum or other imaging apparatus such as is known
13 in the art. Alternatively, drum 10 may have a fixed
14 electrostatic latent image thereon or may be a dielectric
15 material onto which charge is deposited in an image form.

16 Also associated with photoconductive drum 10 are a
17 multicolor liquid developer spray assembly 20, a developing
18 assembly 22, color specific cleaning blade assemblies 34, a
19 background cleaning station 24, an electrified squeegee 26,
20 a background discharge device 28, an intermediate transfer
21 member 30, cleaning apparatus 32, and a neutralizing lamp
22 assembly 36.

23 Developing assembly 22 preferably includes a
24 development roller 38. Development roller 38 is preferably
25 spaced from photoconductive drum 10 thereby forming a gap
26 between development roller 38 and drum 10 which is typically
27 40 to 150 μm and is charged to an electrical potential
28 intermediate that of the image and background areas of
29 photoconductive drum 10. Development roller 38 is thus
30 operative when maintained at a proper voltage to apply an
31 electric field to aid development of the latent
32 electrostatic image.

33 Development roller 38 typically rotates in the same
34 sense as drum 10 as indicated by arrow 40. This rotation
35 provides for the surface of drum 10 and development roller
36 38 to have opposite velocities in their region of
37 propinquity.

38 Multicolor liquid developer spray assembly 20, which is
39 described in more detail herein below, is preferably mounted

1 on axis 42 to allow assembly 20 to be pivoted in such a manner that a spray of liquid
2 toner containing electrically charged pigmented toner particles can be directed either
3 onto a portion of the development roller 38, a portion of the photoconductive drum 10
4 or directly into a development region 44 between drum 10 and development roller 38.

5 Color specific cleaning blade assemblies 34 are operatively associated
6 with developer roller 38 for separate removal of residual amounts of each colored
7 toner remaining thereon after development. Each one of blade assemblies 34 is
8 selectably brought into operative association with developer roller 38 only when toner
9 of a color corresponding thereto is supplied to development region 44 by spray
10 assembly 20. The construction and operation of cleaning blade assembly 34 is
11 described in PCT International Publication number WO 90/14619.

12 Each cleaning blade assemblies 34 includes a toner directing member
13 52 which serves to direct the toner removed by the cleaning blade assemblies 34 from
14 the developer roller 38 to separate collection containers 54, 56, 58 and 60 and thus to
15 prevent contamination of the various developers by mixing of the colors. The toner
16 collected by collection containers 54, 46, 58 and 60 is recycled to a corresponding
17 toner reservoir (55, 57, 59 and 61). A final toner directing member 62 always
18 engages the developer roller 38 and the toner collected thereby is supplied into
19 collection container 64 and thereafter to reservoir 65 via separator 66 which is
20 operative to separate relatively clean carrier liquid from the various colored toner
21 particles. The separator 66 may be typically of the type described in PCT International
22 Publication Number WO90/10896.

23 Background cleaning station 24, which is more clearly shown in Fig. 4,
24 includes a reverse roller 46 and a fluid spray apparatus 48. Reverse roller 46 which
25 rotates in a direction indicated by 50 is electrically biased to a potential intermediate
26 that of the image and background areas of photoconductive drum 10. Reverse roller
27 46 is preferably spaced apart from photoconductive drum 10 thereby forming a gap
28 between reverse roller 46 and drum 10 which is typically 40 to 150 μm .

29 Fluid spray apparatus 48 receives liquid toner from reservoir 65 via
30 conduit 88 and operates to provide a supply of clear non-polar liquid to the gap
31 between photoconductive drum 10 and reverse roller 46. The liquid supplied by fluid

1 spray apparatus 48 replaces the liquid removed from drum 10 by development
2 assembly 22 thus allowing the reverse roller 46 to remove charged pigmented toner
3 particles by electrophoresis from the background areas of the latent image. Excess
4 fluid is removed from reverse roller 46 by a liquid directing member 70 which
5 continuously engages reverse roller 46 to collect excess liquid containing toner
6 particles of various colors which is in turn supplied to reservoir 65 via a collection
7 container 64 and separator 66.

8 An electrically biased squeegee roller 26 such as that described in U.S.
9 Patent 4, 286,039 is preferably urged against the surface of drum 10 and is operative
10 to remove substantially all of the liquid carrier from the background regions and to
11 compact the image and remove liquid carrier therefrom in the image regions. The
12 squeegee roller 26 is preferably formed of resilient slightly conductive polymeric
13 material, and is charged to a potential of several hundred to a few thousands volts
14 with the same polarity as the polarity of the charge on the toner particles.

15 Discharge device 28 is operative to flood the drum 10 with light which
16 is operative to discharge the voltage to discharge the voltage remaining on drum 10
17 mainly to reduce electrical breakdown and improve transfer of the image to
18 intermediate transfer member 30.

19 Intermediate transfer member 30 may be suitable intermediate transfer
20 member such as those described in PCT International Publication WO 90/08984 and
21 is maintained at a suitable voltage and temperature for electrostatic transfer of the
22 image thereto from the image bearing surface

23

1 and therefrom to a final substrate 72. Intermediate transfer
2 member 30 is preferably associated with a pressure roller 71
3 for transfer of the image onto a final substrate 72, such as
4 paper, preferably by heat and pressure.

5 Cleaning apparatus 32 is operative to scrub clean the
6 surface of photoconductive drum 10 and includes a cleaning
7 roller 74, a sprayer 76 to spray a non polar cleaning liquid
8 to assist in the scrubbing process and a wiper blade 78 to
9 complete the cleaning of the photoconductive surface.
10 Cleaning roller 74 which may be formed of any synthetic
11 resin known in the art for this purpose is driven in a
12 direction of rotation opposite to that of drum 10 as
13 indicated by arrow 80. Any residual charge left on the
14 surface of photoconductive drum 10 is removed by flooding
15 the photoconductive surface with light from neutralizing
16 lamp assembly 36.

17 In accordance with a preferred embodiment of the
18 invention, after developing each image in a given color, the
19 single color image is transferred to intermediate transfer
20 member 30. Subsequent images in different colors are
21 sequentially transferred in alignment with the previous
22 image onto intermediate transfer member 30. When all of the
23 desired images have been transferred thereto, the complete
24 multi-color image is transferred from transfer member 30 to
25 substrate 72. Impression roller 71 only produces operative
26 engagement between intermediate transfer member 30 and
27 substrate 72 when transfer of the composite image to
28 substrate 72 takes place. Alternatively, each single color
29 image is transferred to the substrate after its formation.
30 In this case the substrate is fed through the machine once
31 for each color or is held on a platen and contacted with
32 intermediate transfer member 30 during image transfer.
33 Alternatively, the intermediate transfer member is omitted
34 and the developed single color images are transferred
35 sequentially directly from drum 10 to substrate 72.

36 Reference is now made additionally to Figs. 1, 2 and 3
37 in which it is seen that the multicolor toner spray
38 assembly 20 receives separate supplies of colored toner
39 typically from four different reservoirs 55, 57, 59 and 61.

1 Figure 1 shows four different colored toner reservoirs 55,
2 57, 59 and 61 typically containing the colors Yellow,
3 Magenta, Cyan and optionally Black respectively. Pumps 90,
4 92, 94 and 96 may be provided along respective supply
5 conduits 98, 100, 102 and 104 for providing a desired amount
6 of pressure to feed the colored toner to multicolor spray
7 assembly 20. Alternatively, multicolor toner spray assembly
8 20, which is preferably a three level spray assembly,
9 receives supplies of colored toner from six different
10 reservoirs (not shown) which allows for custom colored
11 toners in addition to the standard process colors.

12 Associated with each of reservoirs 55, 57, 59, and 61
13 are typically provided containers of charge director and
14 toner concentrate, indicated respectively by reference
15 numerals 82 and 84 as well as a supply of carrier liquid,
16 indicated generally by reference numeral 86.

17 Each of the reservoirs 55, 57, 59 and 61 also typically
18 receives an input of recycled toner of a corresponding color
19 from developer assembly 22 as described above.

20 Reference is now made to Figs. 2 and 3 which
21 illustrate one embodiment of a multicolor toner spray
22 assembly 20. In the embodiment of Fig. 3 it is seen that
23 there is provided a linear array of spray outlets 106, each
24 of which communicates with one of the four conduits 98, 100,
25 102, and 104. The outlets 106 leave the conduits 98, 100,
26 102 and 104 at one of two levels 108 and 110 to permit the
27 minimization of separation between the outlets 106.

28 The spray outlets 106 are preferably interdigitated
29 such that when four toner colors are used preferably every
30 fourth outlet 106 sprays the same color toner and that
31 every group of four adjacent outlets includes outlets 106
32 which spray four different colors. When six toner colors are
33 used preferably every sixth outlet 106 sprays the same color
34 toner and that every group of six adjacent outlets 106
35 includes outlets 106 which spray six different colors.

36 Colored toner is sprayed under pressure from each of
37 the outlets 106 into the development region 44. The spacing
38 of the spray outlets 106 and their periodicity is selected
39 to enable the toner for each individual given color to

1 substantially uniformly fill region 44. This can result in a
2 uniform array or preferably the colors are grouped in
3 clusters each of which contains one outlet for each color.
4 Typically these clusters have a center to center spacing of
5 between 40-60 mm.

6 In a particular embodiment of Fig. 3 the center to
7 center spacing between two adjacent outlets 106 in the
8 linear array is 6.5 mm, and the spray outlets have an inner
9 diameter of 4 mm. It may be appreciated, however, that the
10 distance between outlets 106 may vary widely in other
11 embodiments of the invention as long as the distribution of
12 liquid toner is sufficient to allow for uniform development.

13 The flow of toner to each of the outlets 106 from
14 conduits 98, 100, 102 and 104 is regulated by valves 112
15 which are controlled by controller 114. The valves 112 may
16 be electrically controlled valves which are opened or closed
17 by controller 114, as for example type 200 valves available
18 from Burkert, Ingelfingen, Germany. In an alternate
19 preferred embodiment of the invention, valves 112 are check
20 (one-way) valves which only allow for flow toward outlets
21 106 and controller 114 is omitted. In a preferred embodiment
22 of the invention a spring loaded non-return valve is used.
23 In this preferred embodiment overall toner flow is
24 controlled by a single valve 120 for each of the colors. In
25 either event, the provision of valves 112 prevents siphoning
26 which would cause dripping from the outlet after the main
27 flow of toner is shut off. Were the toner supply to be shut
28 off only by shutting the supply to the conduits 98, 100, 102
29 and 104 dripping would occur which would result in the
30 mixing of colors, or in a long "dead" time between colors.
31 This individual shut off of each spray outlet or the
32 provision of check valves in each outlet allows for almost
33 instantaneous change of developer color at the development
34 region 44.

35 In any event, the amount of toner that is applied to
36 drum 10 or development roller 38 in accordance with the
37 present invention is sufficient to provide a layer of toner
38 of thickness that at least substantially fills the gap
39 between drum 10 and development roller 38.

1 Reference is again made to Figs. 1 and 2 which
2 illustrate a development assembly 22 and a reverse roller 46
3 constructed and operative in accordance with a preferred
4 embodiment of the invention. The development assembly 22
5 includes development roller 38 which operatively engages
6 photoconductor drum 10 in spaced relationship therewith and,
7 due to its rotation in the same sense as photoconductor drum
8 10, acts inter alia as a metering device. This metering
9 effect ensures that very little liquid carries through the
10 nip of the development region.

11 As noted above, it is known in the art to employ
12 an electrically biased development roller in a liquid toner
13 electrophotographic imaging system. The roller is charged to
14 a suitable voltage somewhere between the voltages of image
15 and background areas of the photoconductive drum. At such a
16 suitable voltage the roller produces good image development
17 without toner deposition on the background.

18 It has been found by the inventors that when the speed
19 of the drum and the development roller are increased to
20 increase the speed of operation of the system there is an
21 unacceptable level of deposition of toner on the background
22 surface at the boundary area between the image and
23 background surfaces downstream of the image areas. This
24 unwanted deposition is hereinafter referred to as
25 "smearing".

26 This phenomenon appears to be the result of the
27 dynamics of toner particle migration in the development zone
28 44 where an electrostatic field is set up between
29 electrically charged development roller 38 and electrically
30 charged image areas and background areas of drum 10.
31 Increasing the voltage difference between background areas
32 of drum 10 and development roller 38 decreases background
33 smearing but, since it also decreases the voltage difference
34 between the image areas of drum 10 and development roller 38
35 it also degrades the image. This image degradation appears
36 to be caused by inhibiting migration of toner particles to
37 the image areas of drum 10 resulting in a reduction in image
38 optical density.

39 When development roller 38, maintained at a voltage

1 which gives good developed image density, but which by
2 itself would result in background smearing, is used in
3 conjugation with background cleaning station 24 improved
4 images are obtained.

5 Background cleaning station 24 comprises a reverse
6 roller 46 typically maintained at a voltage different from
7 the background area of drum 10 which is greater than that of
8 development roller 38. A fluid spray apparatus 48 sprays
9 liquid toner to the region between reverse roller 46 and
10 drum 10 to fill the gap between roller 46 and drum 10 so as
11 to permit electrophoretic migration of toner particles from
12 the background areas of drum 10 to reverse roller 46.

13 Other means can be used for wetting this gap. For
14 example as shown in Fig. 5, a roller 122 is partially placed
15 in a container 124 containing clear liquid, and is rotated
16 to pump clear liquid to the surface of drum 10. Roller 122
17 is either a forward or a reverse roller.

18 Alternatively, as shown in Fig. 6, roller 46 is a
19 forward roller rotating in the direction of arrow 126.
20 Roller 46 is partially placed in a container 128, containing
21 clear liquid and pumps same to the gap between roller 46 and
22 drum 10. Squeegee roller 26 is then operative to remove
23 liquid remaining on the drum therefrom.

24 Roller 46 is maintained at a voltage intermediate
25 the image and background voltages so that toner particles
26 from the image areas of drum 10 are not removed, thereby
27 permitting operation of a color electrostatic imaging system
28 at rates which exceed those which could previously be
29 attained.

30 In a typical system operating at a process speed of 60
31 cm/sec, the image areas of drum 10 are at a voltage of -60
32 volts, the background areas are at a voltage of -1000 volts.
33 Development roller 38 is set to a voltage of -500 volts, is
34 spaced from drum 10 by 60 μm and has a surface speed of 100
35 cm/sec. Roller 46 is a reverse roller at a voltage of -150
36 volts, is spaced from drum 10 by 50 μm and has a surface
37 speed of 95 cm/sec. Negatively charged toner is used in a
38 write-black mode. These voltages and spacings are not fixed
39 values, but depend on process speed, toner charge, mobility

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1 and viscosity, photoconductor type and image light discharge
2 power, the spacing of the rollers from each other, and on
3 other factors.

4 The above mentioned voltages are suitable for the
5 use of negatively charged toner and an organic
6 photoconductor drum. If it is desired to use a positively
7 charged toner or another type of photoconductor material,
8 correspondingly different voltages will be appropriate.

9 This embodiment utilizes multicolor spray assembly 20
10 in which the spray is directed to the development region 44
11 between the drum 10 and development roller 38. Alternatively
12 the spray can be directed toward the surface of
13 photoconductor drum 10 or either generally onto development
14 roller 38 or more preferably toward upper surface of
15 development roller 38. It should be noted that the rotation
16 of development roller 38 is such as to carry the developer
17 liquid away from a development region 44. Nevertheless the
18 multicolor spray assembly produces a sufficient amount of
19 force to assure that there is a supply of liquid developer
20 at the development region.

21 A preferred type of toner for use with the present
22 invention is that described in Example 1 of U.S. Patent
23 4,794,651, the disclosure of which is incorporated herein by
24 reference. Other toners may alternatively be employed. For
25 colored liquid developers, carbon black is replaced by color
26 pigments as is well known in the art.

27 While the invention has been described utilizing a
28 roller developer and a drum photoconductor, it is understood
29 that the invention can be practiced utilizing a belt
30 developer and/or a belt photoconductor.

31 It will be appreciated by persons skilled in the art
32 that the present invention is not limited by what has been
33 particularly shown and described hereinabove. Rather the
34 scope of the present invention is defined only by the claims
35 which follow:

1 **IN THE CLAIMS:**

2 1. Imaging apparatus comprising:

3 an image forming surface arranged for movement in a given
4 direction at a development region whereat a developed visible
5 image is formed at a given process speed using a liquid
6 developer including electrically charged toner particles, the
7 image forming surface having an electrostatic image and
8 background areas at respective first and second potentials;

9 a development surface which is electrified to a third
10 potential intermediate the first and second potentials and is
11 spaced from the image forming surface at the developments
12 region and moves thereat;

13 a background toner removal surface spaced from the image
14 forming surface for the removal of toner particles from the
15 background areas; and

16 means for transferring the developed image to a final
17 substrate.

18 2. Apparatus according to claim 1 and also including means
19 for supplying (48, 122, 124, 128) a liquid to at least a
20 portion of the space between the image forming surface and the
21 background removal surface.

22 3. Apparatus according to claim 1 or claim 2 wherein a
23 portion of the background removal surface is closely spaced
24 from the image forming surface and the portion moves in the
25 given direction (126).

26 4. Apparatus according to any of the preceding claims
27 wherein the image forming surface is a surface of a drum (10)
28 rotating about a drum axis.

29 5. Apparatus according to claim 4 wherein the background
30 removal surface is the surface of a rotating roller (46)
31 having an axis parallel to the axis of the drum and wherein

1 the rotating roller and rotating drum rotate in opposite
2 senses.

3 6. Apparatus according to claim 1 or claim 2 wherein a
4 portion of the background removal surface is closely spaced
5 from the image forming surface and the portion moves in a
6 direction which is opposite to the given direction (50).

7 7. Apparatus according to claim 6 wherein the image forming
8 surface is a surface of a drum (10) rotating about a drum
9 axis.

10 8. Apparatus according to claim 7 wherein the background
11 removal surface is the surface of a rotating roller (46)
12 having an axis parallel to the axis of the drum and wherein
13 the rotating roller and rotating drum rotate in the same
14 sense.

15 9. Apparatus according to any of the preceding claims
16 wherein the development surface is the surface of a rotating
17 roller (38) having an axis of rotation perpendicular to the
18 given direction.

19 10. Apparatus according to any of claims 1-9 wherein the
20 development surface is the surface of a rotating roller (38)
21 having an axis of rotation perpendicular to the given
22 direction and the rotating roller and rotating drum rotate in
23 the same sense.

24 11. Apparatus according to any of the preceding claims
25 wherein the development surface and the background removal
26 surface are charged to respective third and fourth electrical
27 potentials intermediate the first and second electrical
28 potentials.

29 12. Apparatus according to claim 11 wherein the third and
30 fourth potentials are different from each other.

1 13. Apparatus according to claim 11 or 12 wherein the fourth
2 electrical potential is closer to the value of the first
3 electrical potential than is the third electrical potential.

4 14. A method of providing an image on a substrate comprising
5 the steps of:

6 providing an electrostatic image including image and
7 background areas at respective first and second electrical
8 potentials on an image forming surface;

9 moving the image forming surface in a given direction at
10 a development region;

11 developing the electrostatic image using a liquid
12 developer including electrically charged toner particles to
13 form a developed image the step of developing utilizing a
14 developer surface that is electrified to a potential
15 intermediate the first and second potentials, that is spaced
16 from the image forming surface at the development region and
17 that is moving thereat;

18 removing toner particles undesirably deposited on the
19 background area during the step of developing utilizing a
20 background removal surface spaced from the image forming
21 surface at a background removal region; and

22 transferring the developed image to a final substrate.

23 15. A method according to claim 14 and also including the
24 step of supplying a liquid to at least a portion of the space
25 between the image forming surface and the background removal
26 surface.

27 16. A method according to claim 14 or claim 15 and comprising
28 the steps of:

29 closely spacing a portion of the background removal
30 surface from the image forming surface; and

31 moving the portion in the given direction.

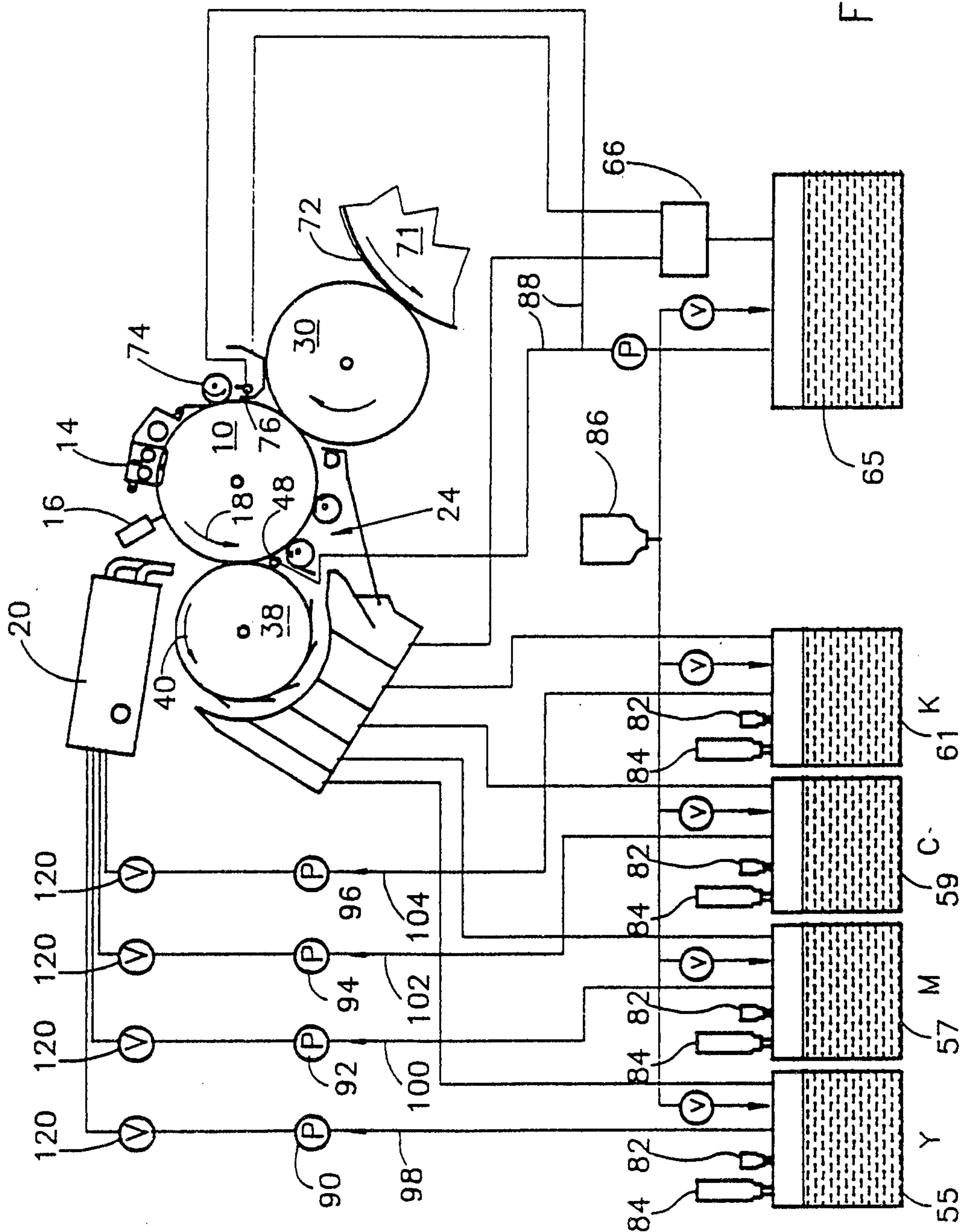
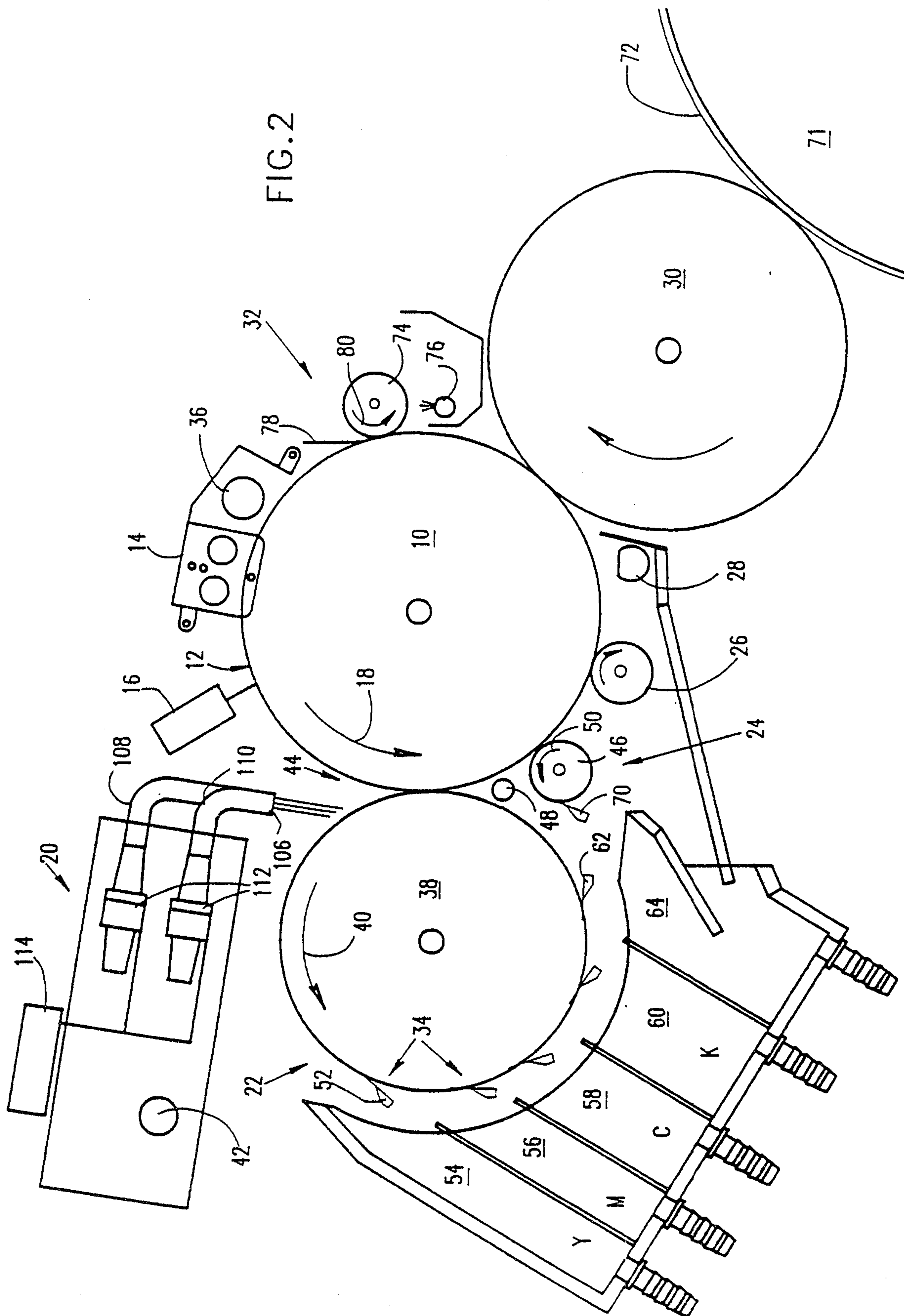


FIG. 1

FIG. 2



SUBSTITUTE SHEET

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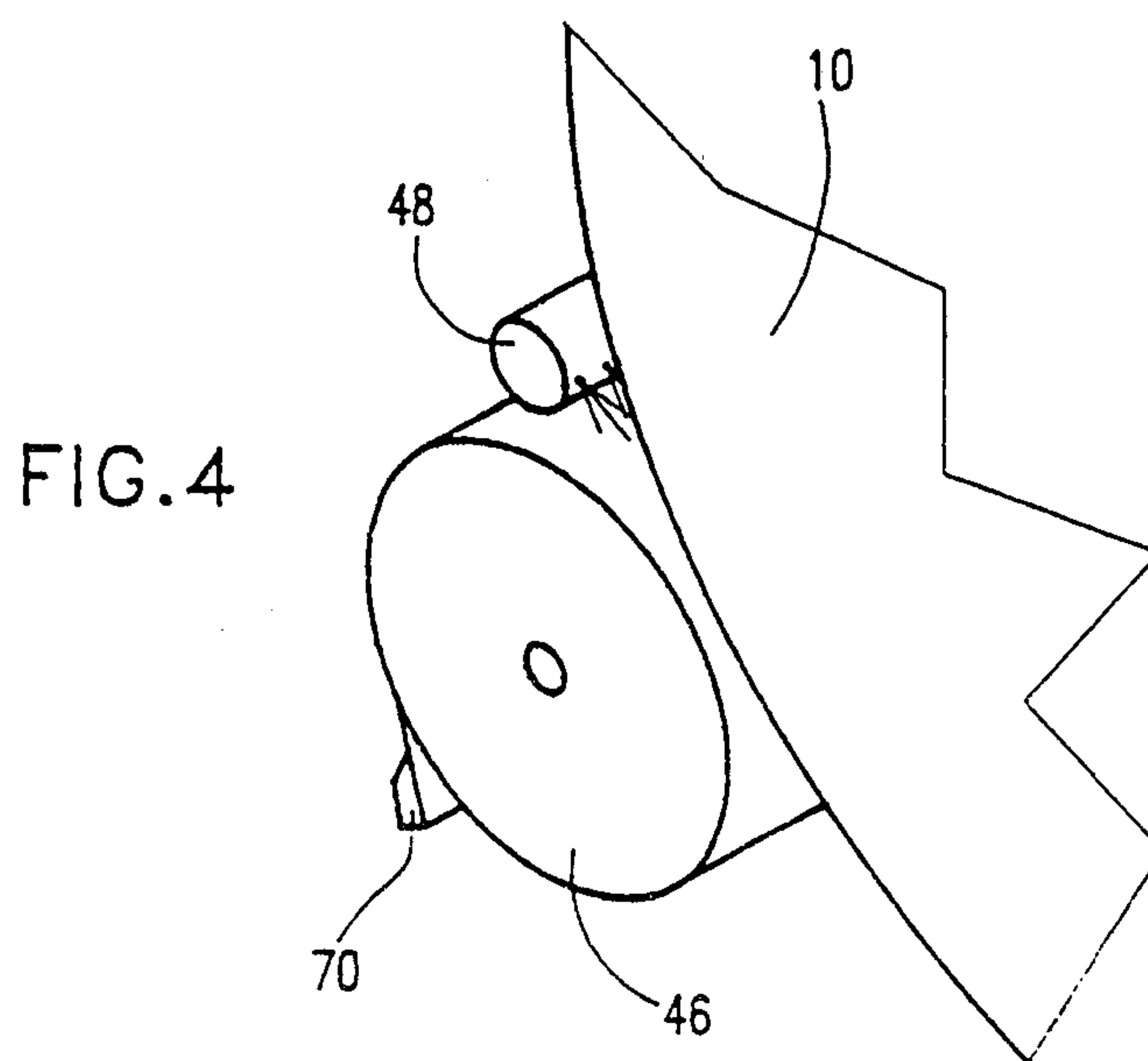
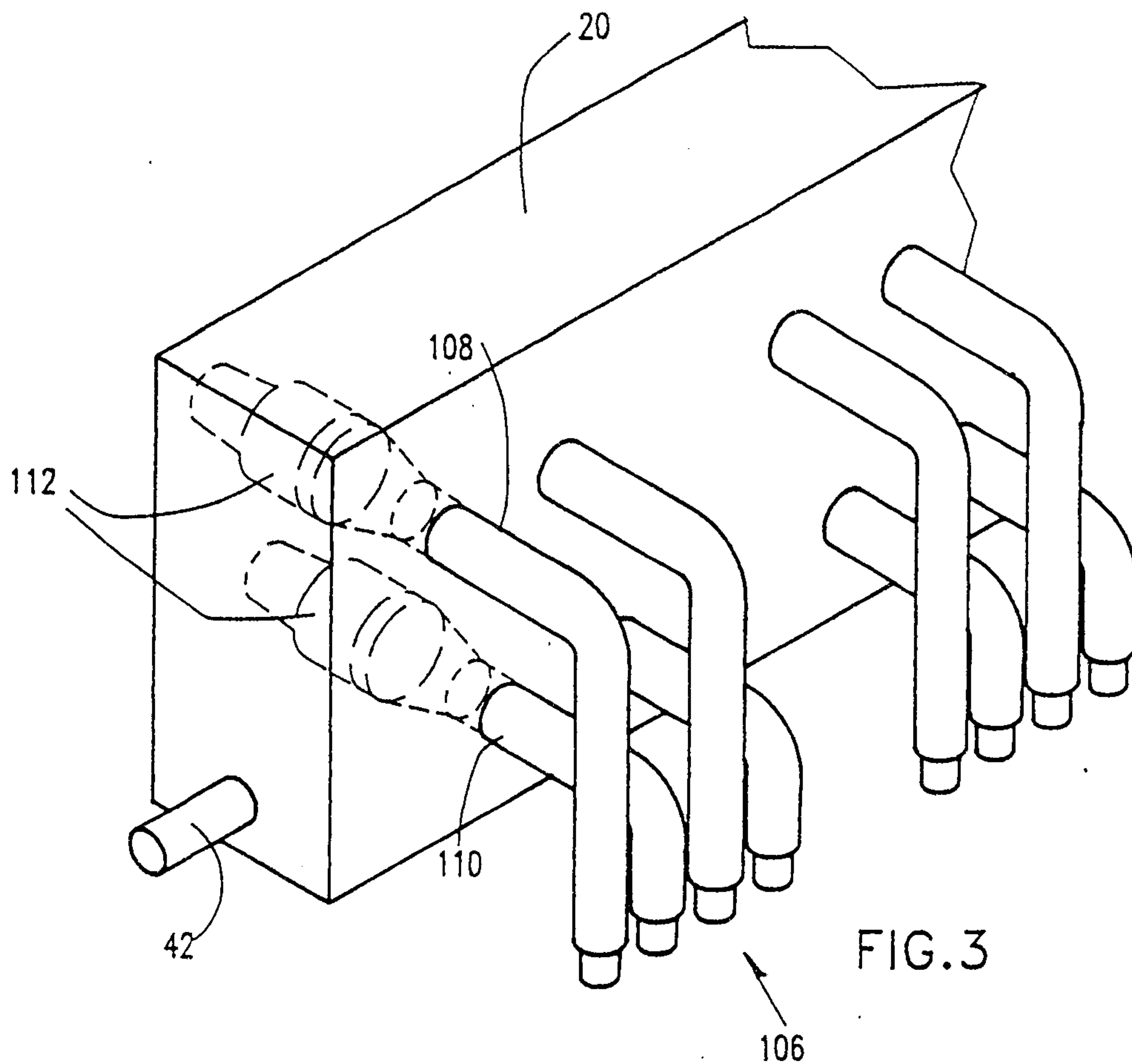


FIG. 5

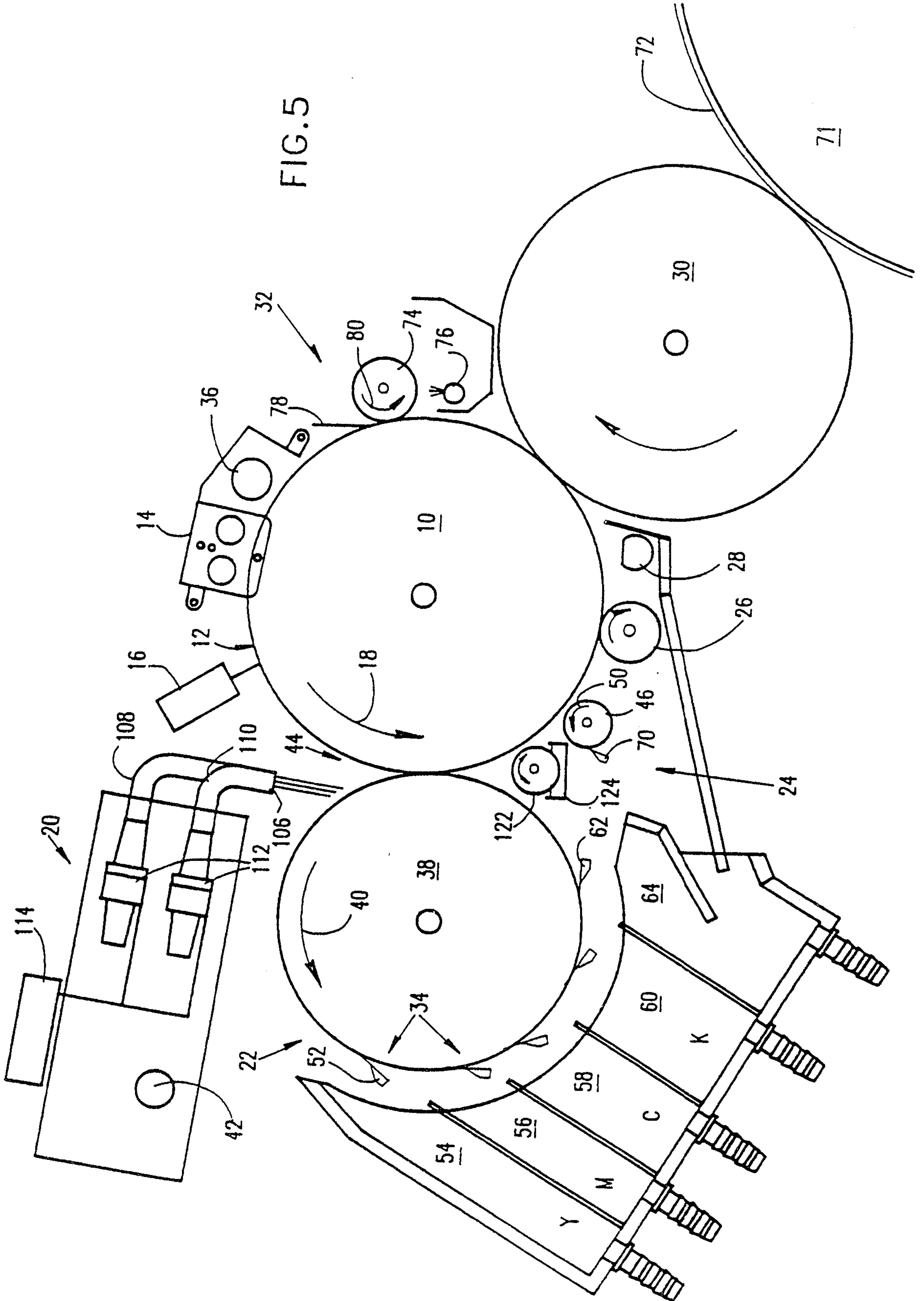


FIG. 6

