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(54) A SYSTEM FOR SUPPLYING AN INKJET HEAD

(57) The system comprises: two tanks (2, 3), a first and a second, for storing ink, sealedly closed, connected to one another by means of a first conduit (4) associated to a first pump (6) and further connected respectively with the delivery and discharge of the supply channel of at least a head (T), by means of a second (12) and a third (13) conduit; an open-topped regulating tank (8), connected to the two storage tanks (2, 3) respectively with a first (10) and a second (11) pipeline for maintaining the storage tanks full. The air bubbles coming from the head involve, in order, the first storage tank (2), the second storage tank (3) and lastly the regulating tank (8) which discharges them into the atmosphere.

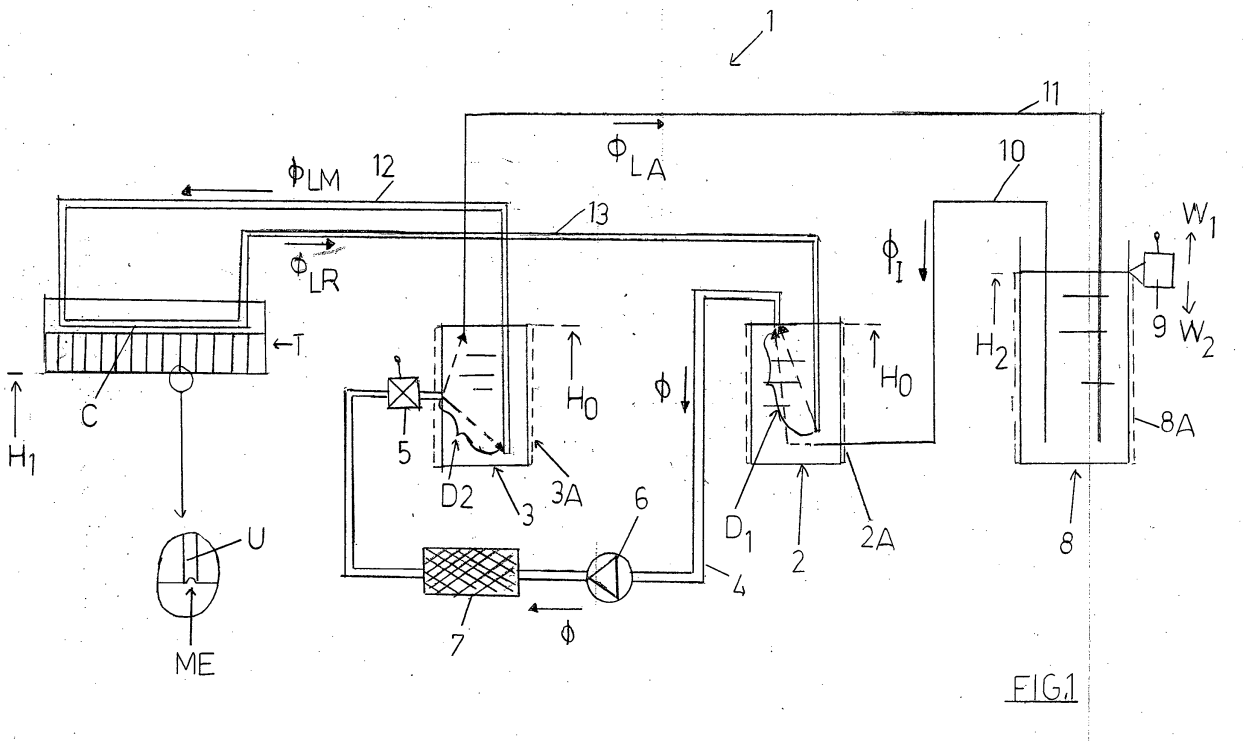

FIG.1

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Description

[0001] Apparatus are known for supplying one or more inkjet heads.

[0002] US2010/085396 discloses an apparatus comprising a main tank, a recycling tank and a source of depression for regulating a meniscus of the dispensing nozzles of the heads.

[0003] US2008/299321 discloses a buffer tank which regulates the meniscus at the nozzles of the head by means of the level difference of the ink in the buffer tank and the level of ink in the head.

[0004] US2011/242156 discloses an apparatus in which a storage tank is included internally of which an air cushion is included.

[0005] Document B02012A 000126 discloses a system comprising a regulating tank of the meniscus of the nozzles of the head, two storage tanks, supplied by the tank, in each of which an air cushion is included.

[0006] It is known that the activation of the nozzles of the heads, for example by means of piezoelectric means, causes a "firing" externalwise (in particular on an underlying article, for example a tile) of droplets of ink and a contemporaneous recall from outside of air bubbles which cross the nozzles by getting into the supply channel to the head and from there into the ink supply to the head.

[0007] The presence of air in the circuit causes a series of drawbacks: for example due to the high compressibility of air with respect to ink, faults are generated during the activation time of the nozzles, such as the absence of the "firing" of the drops of ink.

[0008] In apparatus with storage tanks in which an air cushion is included, the air injected into the supply circuit of the ink through the nozzles increases the thickness of the air cushion, gradually reducing the quantity of ink available in the storage tank (or the tanks); in the long run this causes series supply problems to the head (in particular for a head having a high printing capacity) up to de-supplying the head, with all the drawbacks that brings, well known to the expert in the sector.

[0009] It is known that to realise an excellent print, it is necessary to maintain the value and viscosity of the ink within a predetermined range; this is obtainable by controlling the value of the temperature of the ink without a predetermined range (for example $\pm$ 0,5° C).

[0010] The delivery of the supply channel of the nozzles of the heads is connected to an end of a supply pipeline the remaining end of which sources from close to a bottom of a relative storage tank.

[0011] The tank is heated so as to respect the rated value of the ink temperature at least at the sourcing end of the supply pipeline.

[0012] Also known is that the temperature in the tank rises from the bottom towards the top; in the presence of an air cushion the temperature thereof is increased with respect to the adjacent layer of ink due to the lower heat capacity of air with respect to the ink.

[0013] Increases in the flow of ink demanded by the head (more precisely by the plurality of heads the printing device is composed of) provoke, also due to the delay with which the regulating tank supplies the storage tank, recall by the supply channel of the upper layers of ink in the storage tank, which, being at a higher temperature than the rated temperature, can cause variations not tolerated by the viscosity of the ink with the consequent drawbacks known to the expert in the sector.

[0014] IT 272.558 discloses an apparatus comprising a plurality of printing heads; the delivery of the supply channel of each printing head is derived from a supply ring of the ink in turn supplied by the ink supply pipeline.

[0015] The discharge of the supply channel of each head is connected to a collecting ring that communicates, via a conduit, with a relative ink tank.

[0016] It is known that the printing devices are constituted by consecutive groups of heads, with the heads of a group, arranged in a row, offset with respect to the heads of the adjacent group.

[0017] The heads of a group are activated contemporaneously, but at different times with respect to the activation of the heads of the remaining groups.

[0018] In IT 272.558 the distance between the discharges of the supply channels of the heads and the collecting ring is constant: it follows that the portions of air injected into the supply channels via the nozzles of the relative heads reach the collecting channel at the same time. This is an "air pulsation" which can obstruct the successive air "pulsation" coming from the group of heads that are active successively.

[0019] The aim of the present invention is to provide a system for supplying the inkjet heads which obviates the drawbacks of the prior art, in particular a system able to discharge to the outside the air injected into the ink through the dispensing nozzles of the heads.

[0020] A further aim of the invention is that it provides a system that not only attains the above-mentioned advantages, but is also able to make the temperature of the ink supplied to the printing heads uniform.

[0021] A further aim of the invention is to regularise the flow of air bubbles coming from the supply channels to the heads.

[0022] A further aim of the invention is to provide a system that not only attains the preceding advantages, but is also extremely functional and reliable.

[0023] The above aims are attained in accordance with the contents of the claims.

[0024] The characteristics of the invention will emerge from the description that follows which refers by way of non-limiting example to the appended tables of drawings, in which:

- figure 1 schematically illustrates, according to the present invention, a supply system for inkjet heads;
- figure 2 is a schematic illustration of an implementation of the system of figure 1;

- figure 3 schematically illustrates, in plan view, an arrangement of the heads of the printing device supplied by the above system;

- figure 4 schematically illustrates the connections between the discharges of the inkjet supply channels and a collecting ring of the ink in arrival from the discharges.

[0025] With reference to figure 1, reference numeral 1 denotes a supply system for a plurality of inkjet heads, comprising a first 2 and a second 3 ink storage tank that are sealedly superiorly closed.

[0026] A first conduit 4 sets in communication, with consent of a first solenoid 5, the top of the first tank 2 with the central part of the second tank 3; this conduit is associated to a first pump 6 and a filter 7 interposed between the pump and the second storage tank 3.

[0027] An open-top regulating tank 8 is provided, containing ink, supplied with ink by known systems, not illustrated, working in connection with a level sensor 9 that is height-adjustable according to the arrows W_1, W_2; the level sensor 9 having the function of maintaining the ink level internally of the regulating tank at a height H_2 that is greater than a height H_0 of the storage tanks 2,3.

[0028] The regulating tank 8 is connected to the lower part of the first storage tank 2, by means of a first conduit 10 and with the top of the second storage tank by means of a second conduit 11.

[0029] The system can contemporaneously supply, with the same ink, inkjet head groups in parallel, each group being constituted by equi-distanced heads T, supplied contemporaneously and arranged in an offset order with respect to the heads of another group.

[0030] In the following part of the description, reference will be made, for the sake of simplicity, to a single head T as illustrated in figures 1,2.

[0031] A technical expert in the sector will know that the characteristics of the system of the present invention will be attainable also with the groups of heads mentioned in the foregoing.

[0032] A second conduit 12 originating in proximity of the bottom of the second storage tank 3 connects the tank 3 with the delivery of the supply channel C of the head T; a third conduit 13 originating in proximity of the bottom of the first storage tank 2 connects the latter with the discharge of the above-mentioned channel C.

[0033] The sections of the first 4, second 12 and third 13 conduits are considerably greater than the sections of the conduits 10, 11; this will be explained more fully with reference to the functioning of the present system 1.

[0034] The storage tanks 2, 3 are externally associated to heating means of an electrical type 3A, 4A able to keep the ink internally of the tanks at a predetermined temperature, for example 45÷50 degrees Celsius, thus optimising the viscosity characteristics thereof.

[0035] The regulating tank 8 is also externally associated to electrical heating means 8A for pre-heating the ink to a temperature of about 25°C.

[0036] The heating means, as well as the solenoid 5 and the level sensor 9, are controlled and managed by a suitable control board not indicated in the drawings as being of known type to the expert in the sector.

[0037] Using known techniques the storage tanks 2, 3 are completely filled with ink; this technical-functional aspect is maintained by the system during inkjet printing of the head T as the height H_2 of the ink level in the regulating tank 8 is greater than the height H_0 of the top of the storage tanks 2, 3.

[0038] The determining of the height H_2 is regulated as a function of the chemical-physical characteristics of the ink during the preliminary set-up operations during the course of which operations the head T is installed, with the aim of regulating the meniscus ME, i.e. the dispensing height H_1 of the head T.

[0039] In the embodiment of the appended figures, the height H_2 is greater than height H_1; this does not constitute a limitation, as the height H_2 might be lower than the height H_1.

[0040] The inkjet head T comprises a plurality of dispensing nozzles U which act to apply, in a controlled way, ink on the printing surface, for example a ceramic tile.

[0041] For example the nozzles U can be of a piezoelectric type which upon the action of modulated electrical pulses determines the dispensing of small droplets of ink.

[0042] A description of the functioning of the above-described system now follows.

[0043] The control board intervenes to activate the solenoid 5 and the pump 6: the pump 6 sets the ink contained in the second storage tank 3 under pressure.

[0044] As described, the section of the second conduit 12 is greater than the section of the second pipeline 11; by way of example, if ϕ denotes the main ink flow crossing the pump 6, 80% of this flow, or printing flow, denoted by ϕ_{LM}, is directed towards the second conduit 12 and the remaining 20%, or recycling flow, denoted by ϕ_{LA}, flows in the second pipeline 11 and pours into the regulating tank 8.

[0045] The printing flow crosses the channel C of the head T (which supplies the nozzles U); a fraction of this flow involves the nozzles U of the head so that at the outlet of the channel C there is a return flow ϕ_{LR} which crosses the third conduit 13 (the section of which is at least equal to the section of the second conduit 12) then to flow into the first storage tank 2.

[0046] The aspiration of the pump 6 is connected to this tank; this enables aspirating a flow ϕ_I from the regulating tank 8, via the first pipeline 10, which flow ϕ_I is summed to the return flow ϕ_{LR} and resets the main flow ϕ which crosses the first conduit 4.

[0047] As already mentioned in the foregoing, the activation of a nozzle U causes a "firing" of drops of ink and the intake from outside of minute air bubbles which cross the nozzle U and enter the channel C of the head.

[0048] It follows that the return flow ϕ_{LR} contains air (precisely traces of air) which is conveyed into the first

storage tank 2; the air rises spontaneously towards the upper part of the storage tank 2 and is channelled, together with the main flow ϕ_P, into the first conduit 4 so as to open into the second storage tank 3 and rise spontaneously upwards in order to be directed, together with the recycling flow ϕ_{LA}, into the second pipeline 11.

[0049] This is facilitated by the fact that the first conduit 4 enters the tank 3 in a central position and the lower end of the second conduit 12 sources from the bottom of the tank 3 in proximity of the wall thereof opposite the wall in which the first conduit 4 opens; in this way the air, which rises spontaneously upwards, can in no way be captured by the lower end of the second conduit 12.

[0050] It follows that this air is discharged into the regulating tank 8 and lastly into the atmosphere, as the tank has an open top.

[0051] Definitively, the system of the invention enables discharging into the atmosphere the air which, through the activated nozzles, enters the channel C of the head T.

[0052] In this way the formation of air bubbles is prevented which at the moment of printing would provoke dispensing, through the nozzles U, of sprays of ink (exploding droplets) which would considerably alter the quality of the printing.

[0053] The present invention uses ink storage tanks not having an air cushion, i.e. tanks full of ink; in this way the drawbacks relating to the prior art are obviated.

[0054] It is specified that the pump 6 used does not cause pulsation in the relative delivery that might alter the level of the ink at the meniscus ME.

[0055] The proposed technical solution of the present invention does not include the use of sources in depression able to maintain the ink in suspension with the aim of giving rise to the meniscus; this guarantees the maximum stability of the meniscus and prevents formation of a "film", i.e. a film of ink in the internal surface of the nozzles which, in the prior art, blocked the outlet of the ink from the nozzle or was the cause of an alteration of the dispensing trajectory of the ink.

[0056] Figure 1 shows that the end of the third conduit 13 (the one not involved with the head T) is situated in proximity of the bottom of the first storage tank 2; likewise the initial part of the second conduit 12 is situated in proximity of the bottom of the second storage tank 3.

[0057] A further technical-functional aspect is the fact that the first conduit 4 opens into the central part of the second storage tank.

[0058] It follows that the flows ϕ_{LR}, ϕ_I (the sum of which is equal to the main flow ϕ) involve the first storage tank 2 for a portion D_1 thereof a little smaller than the height thereof.

[0059] The printing flow ϕ_{LM} involves the second storage tank for a portion D_2 thereof practically equal to a half of the height thereof.

[0060] The technical-functional aspects mentioned above enable making the ink flow temperatures uniform, together respecting the predetermined range of the temperature of the flows ($\pm$ 0.5°C), with a consequent maintaining of the viscosity to the required levels.

[0061] It is known that the supply to the head T in two opposite directions significantly limits the formation of encrustation both in the head and in the system 1.

[0062] Figure 1 shows the directions of the flows involving the system 1; figure 2 shows the opposite directions.

[0063] It is specified that the situation of figure 2 occurs in the absence of printing, i.e. with the nozzles U deactivated.

[0064] Figure 2 illustrates a fourth conduit 40 which connects the top of the second storage tank 3 with the central part of the first storage tank 2; this conduit 40 is associated to a second pump 30, a filter 31 interposed between the delivery of the pump 30 and the first tank 2 and lastly a second solenoid 32, the solenoid 32 and the second pump 30 being controlled and managed by the same control board.

[0065] The inversion of the flows of ink in the head T and in the system 1 is actuated following the deactivating of the first solenoid 5 and the first pump 6 and the contemporaneous activating of the second solenoid 32 and the second pump 30.

[0066] The flow of ink α moved by the second pump 30 is injected, via the fourth conduit 40, into the first storage tank 2.

[0067] Following this the third conduit 13 and the first conduit 10 are respectively involved by flows α_{LR}, α_I; for the reasons already explained in the foregoing, the rate of those flows being defined by the ratio of the sections of the conduit 13 and pipelines 10, for example four (i.e. ϕ_{LR} is 80% of α, α_I is 20% of α).

[0068] The flow α_{LR} crosses, in order, the channel C of the head and the second conduit 12 so as to pour into the second storage tank 3; as already mentioned, the head T is not printing, so the flow of ink in outlet from the head T is equal to the flow in inlet; further, as the nozzles U are not activated, there are no traces of air in the ink flow in outlet from the supply channel C of the head.

[0069] A flow α_L collected from the regulating tank 9 via the second pipeline 11 also pours into the second tank 3; this flow α_L is equal to the flow α_I injected into the regulating tank 9.

[0070] In the second storage tank 3, the zone involved by the ink flow is practically equal to the height of the tank 3; in the first storage tank 2, the zone interested by the flow of ink is practically equal to half the height of the tank 2.

[0071] These fundamental aspects, deriving from constructional aspects of the tanks 2,3 and the conduits and pipelines connected thereto, enable making the ink temperature uniform, with all the positive aspects concerning the viscosity of the ink.

[0072] The configuration of the system of figure 2 does not enable discharging into the atmosphere traces of air trapped in the ink; this does not constitute a limitation as the configuration of figure 2 is actuated during the printing pauses, i.e. with the nozzles deactivated.

[0073] As mentioned in the foregoing, the printing apparatus include a series of heads T, ordered in groups.

[0074] By way of example, figure 3 schematically illustrates a printing apparatus 50 in which two groups G_1,G_2 of heads are represented; each group is constituted, for example, by a plurality of aligned and equi-distanced heads.

[0075] The heads T_1-T_5 of the group G_1 are offset with respect to the heads T_6-T_{10} of the remaining group G_2.

[0076] The combination of the two groups identifies an operating width L that is at least equal to the width of an article 100 (for example tiles), made mobile according to the direction of the arrow X, on which the printing is realised.

[0077] As is known, the heads T_1-T_5 of a group G_1 are activated contemporaneously but before (in the illustrated example) the activation of the heads T_6-T_{10} of the remaining group G_2.

[0078] S,S_1 denote the supply channels respective of the heads T_1-T_5,T_6-T_{10}.

[0079] A collecting ring 60 is located by a side of the apparatus 50 (see figure 4) of the ink flow coming from the discharges S,S_1 of the heads T_1-T_{10}; a similar ring, not illustrated, supplies the deliveries M,M_1 of the above-mentioned heads; the third conduit 13 originates from the ring 60.

[0080] Tubes are included for connecting the discharges S,S_1 to the ring 60; the pathways of the tubes, denoted by P_1-P_{10} are different to one another, which is particularly advantageous.

[0081] In fact, following activation of the heads T_1-T_5, ink containing small air bubbles exits from the discharges S of the supply channels C.

[0082] The air bubbles relative to the head T_1 involve the pathway P_1 and then flow into the ring 60 after a time t_1.

[0083] The air bubbles relative to the head T_2 involve the pathway P_2 and then flow into the ring 60 after a time $t_{2.,}$ longer than t_1.

[0084] This continues for the air bubbles relative to the heads T_3,T_4,T_5 which flow into the ring in times following the times t_1,t_2 relative to the heads T_1,T_2.

[0085] There is, in definition, a gradual entry of the air bubbles into the ring 60, which is extremely advantageous as this aspect does not influence the tubes relative to the discharges S_1, the heads T_6-T_{10} (it does not create disturbance in the functioning of the heads T_6-T_{10}) and further enables not overloading the system of the present invention with "air pulsation".

[0086] Like considerations are valid also following activation of the heads T_6-T_{10}.

[0087] The system of the present invention enables discharging the air trapped by the ink to the outside, with all the advantages this brings.

[0088] Further, the conformation of the components defining the above system enables making the temperature of the ink uniform: the consequent advantages are evident to an expert in the sector.

[0089] The technical-functional details relating to the supply of the heads, in particular the collecting and management modes of the ink discharged from the heads, prevents both interferences in the functioning thereof and overloading of the disclosed "air pulsation" system.

[0090] In the illustrated embodiment, it has been specified that the diversity of the value of the sections of the second 12 and third 13 conduits with respect to the sections of the first and second pipelines 10,11, determines different flow rates of the flows crossing the conduits 12,13 and the pipelines 10,11; for example, the following have been supposed: ϕ_{LM} equal to 80% of ϕ and ϕ_{LA} equal to 20% of ϕ.

[0091] This diversity of the flows can be obtained also without varying the value of the sections, for example by including in the conduits 12,13 and/or pipelines 10,11, suitable pumps to ensure that the flow ϕ generated by the first pump 6 is divided into a flow ϕ_{LM} considerably greater than ϕ_{LA}.

[0092] The above has been described by way of example, and any variants of a practical-applicational nature of the solution proposed are understood to fall within the protective scope of the invention as described in the following.

Claims

1. A system for supplying inkjet heads, **characterised in that** it comprises: an open-top regulating tank (8) associated both to regulating means (9) of a level (H_2) of ink contained by the tank, and to heating means (8A) for reheating the ink; a first sealed storage tank (2) containing ink, supplied by the regulating tank (8) by means of a first pipeline (10), a top of the tank (2) exhibiting a height (H_0) that is lower than the level (H_2) of ink in the regulating tank (8), first heating means (2A) being provided for maintaining a temperature of the ink contained by the first tank at a predetermined temperature; a second sealed storage tank (3), containing ink, supplied by the regulating tank (8) by means of a second pipeline (11), a top of the second tank (3) exhibiting a height (H_0) that is lower than the level (H_2) of ink of the regulating tank (8), second heating means (3A) being provided for maintaining the temperature of the ink contained by the second tank at a predetermined temperature; a first conduit (4), connecting the first storage tank (2) with the second storage tank (3), connected with a first pump (6) a delivery of which is facing towards the second tank (3); a second conduit (12) connecting the second storage tank (3) with the delivery of a supply channel (C) of at least an inkjet head (T); a third conduit (13) connecting a discharge of the supply channel (C) with the first storage tank (2).

2. The system of claim 1, **characterised in that** the

second conduit 12 and the third conduit 13 are subject to means which define, via the conduits 12, 13, flow rates of ink ϕ_{LM}, ϕ_{LR} that are considerably greater than the flow rates of ink ϕ_{LA}, ϕ_{I} respectively crossing the second (11) and first (10) pipelines, the flow rates being equal to determined percentages of the flow rate of ink ϕ generated by the first pump (6).

3. The system of claim 2, **characterised in that** the means are located in sections of the second conduit (12) and the third conduit (13) which are considerably greater than the sections of the first pipeline (10) and the second pipeline (11).

4. The system of the preceding claim, **characterised in that** the ends of the second (12) and third (13) conduit immersed in the relative second storage tank (3) and first (2) storage tank are positioned in proximity of the bottom of the relative tanks, **in that** the end of the first pipeline (10) immersed in the first storage tank (2) is positioned in proximity of the bottom of the tank, and **in that** the end of the second pipeline (11) communicating with the second storage tank (3) originates at the top of the tank.

5. The system of claim 4, **characterised in that** the end of the first conduit (4) associated to the delivery of the first pump (6) opens in the second storage tank (3) at an intermediate point of a lateral wall thereof, and **in that** the remaining end of the first conduit originates from the top of the first storage tank (2).

6. The system of claim 5, **characterised in that** the end of the second conduit (12) positioned in proximity of the bottom of the relative second storage tank (3) is adjacent to a vertical wall of the second storage tank (3) which vertical wall is opposite a wall in which the first conduit (4) opens into the tank.

7. The system of any one of the preceding claims, **characterised in that** it comprises: first electrical check means (5) of the ink flow through the first conduit (4); a fourth conduit (40), connecting the second storage tank (3) with the first storage tank (2), connected to second electrical check means (32) of the ink flow crossing the fourth conduit and to a second pump (30) a delivery of which is facing towards the first storage tank (2), activation and deactivation of the second electrical means (32) being subordinated respectively to the deactivation and activation of the first electrical means (5).

8. The system of claim 7, **characterised in that** the end of fourth conduit (40) associated to the delivery of the second pump (30) opens in the first storage tank (2) at an intermediate point of a lateral wall thereof, and **in that** the remaining end of the fourth conduit (40) originates from the top of the second storage tank (3).

9. The system of claim 8, **characterised in that** the end of the third conduit (13) positioned in proximity of the first storage tank (2) is adjacent to the lateral wall of the first storage tank (2), which wall is opposite the wall in which the fourth conduit (40) opens into the first storage tank (2).

10. The system of claim 1, wherein the heads are ordered in at least two groups (G_1, G_2), with the heads (T_1-T_5) of a group (G_1) aligned and equidistanced, as well as staggered with respect to the heads (T_6-T_{10}) of the remaining group defining an operating printing width (L), **characterised in that** the discharges (S, S1) of the supply channels (C) of the heads (T1-T10) are connected by means of a corresponding tubes, to a collecting ring (60) communicating with the third conduit (13), the pathways (P1-P10) from the discharges (S, S1) to the ring (60) have a different and progressive value so as to cause the ink coming from the discharges to gradually flow together, with relative air bubbles, to the collecting ring.

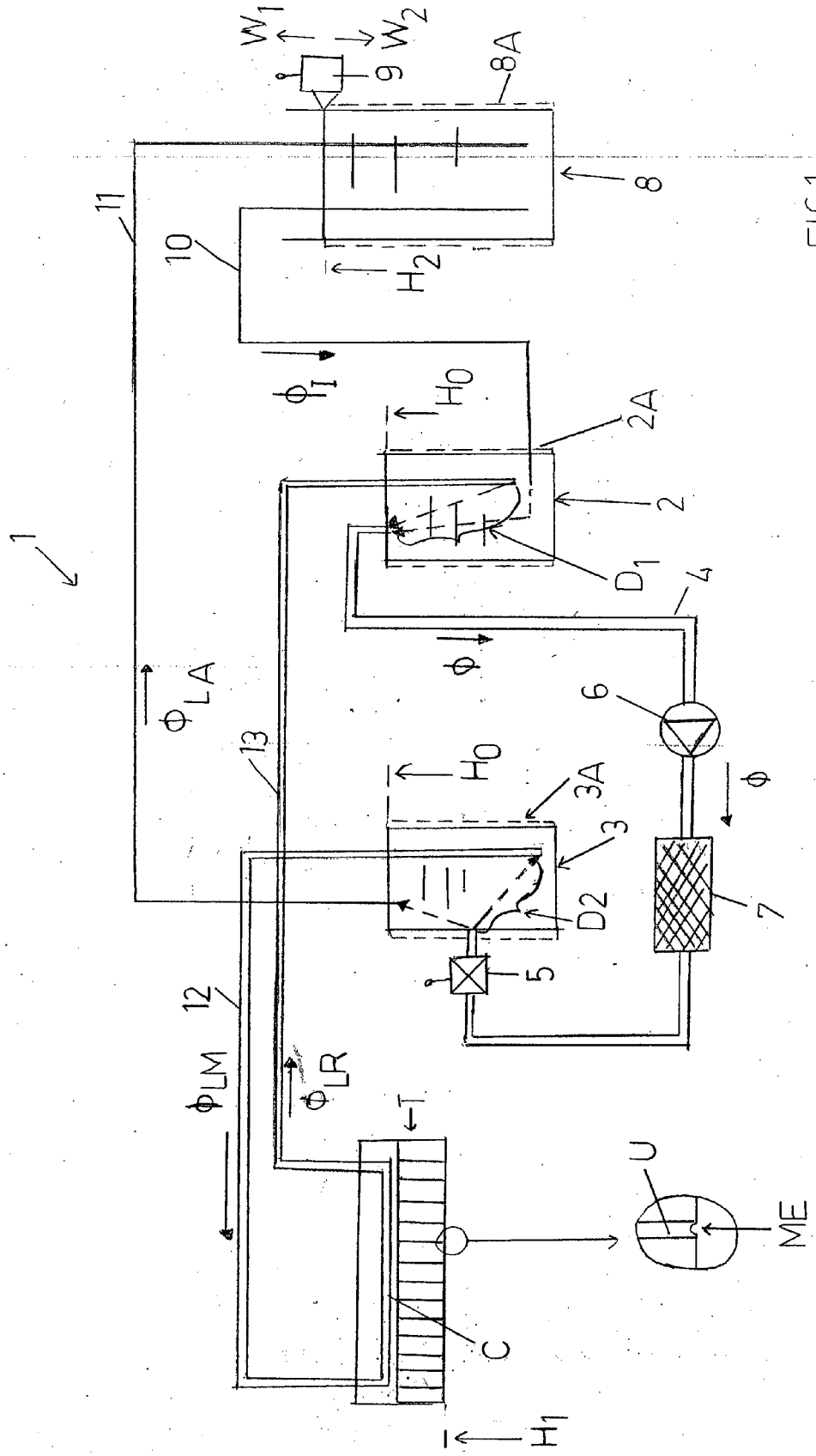
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FIG.1

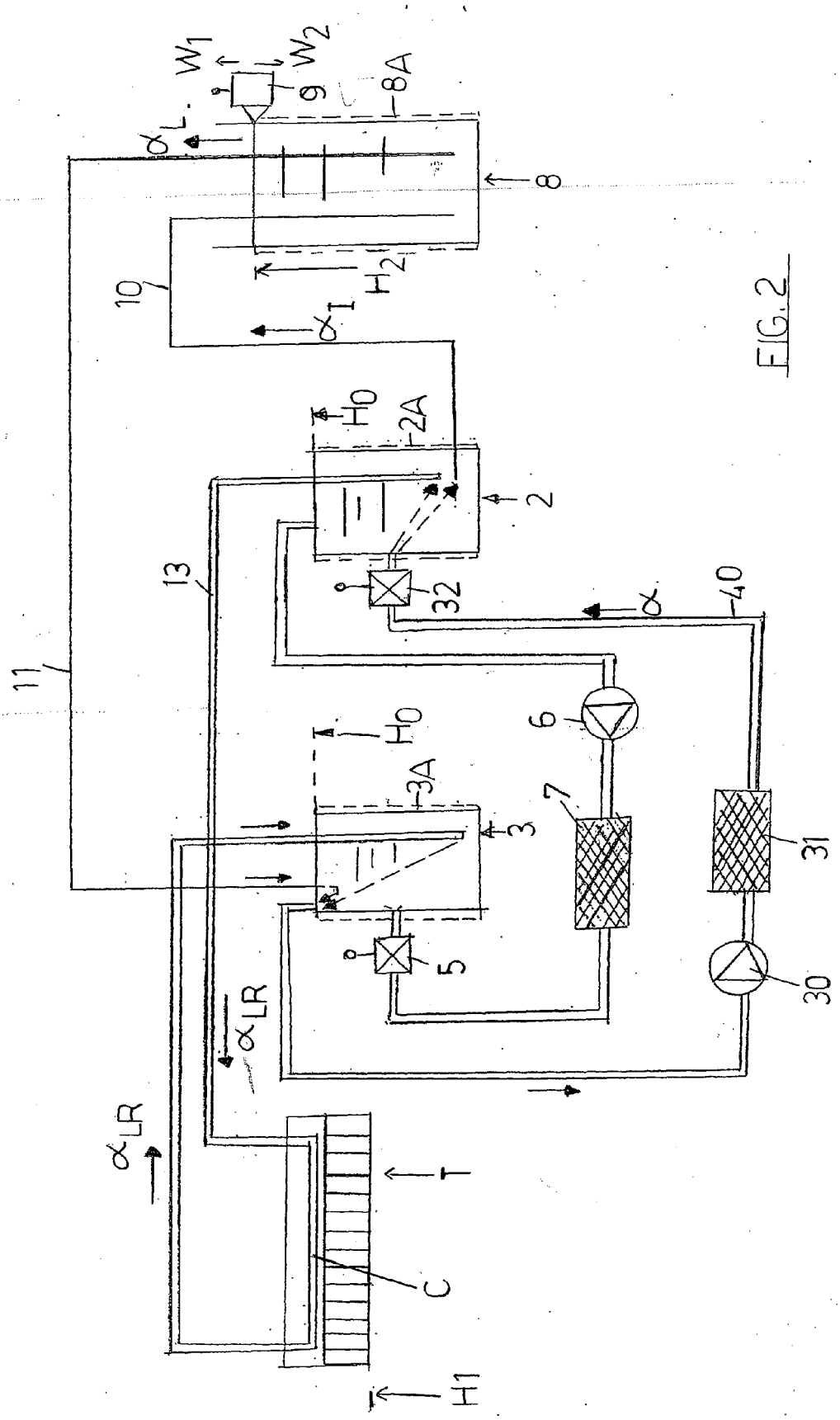
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FIG. 2

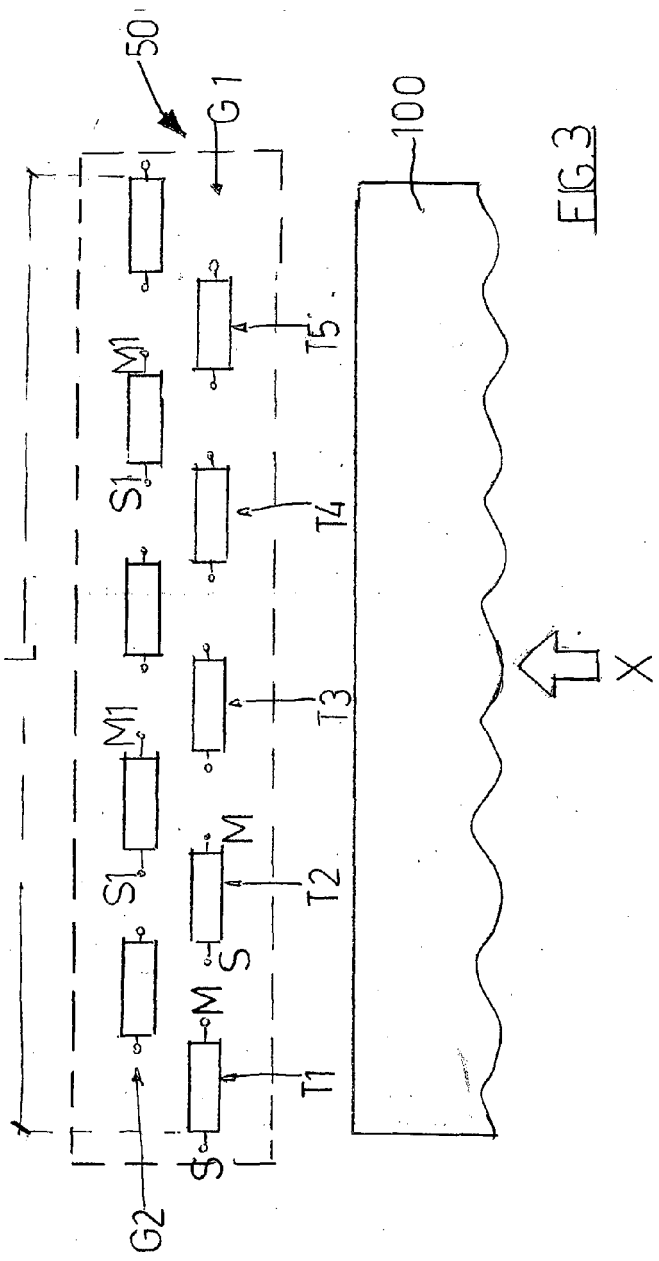
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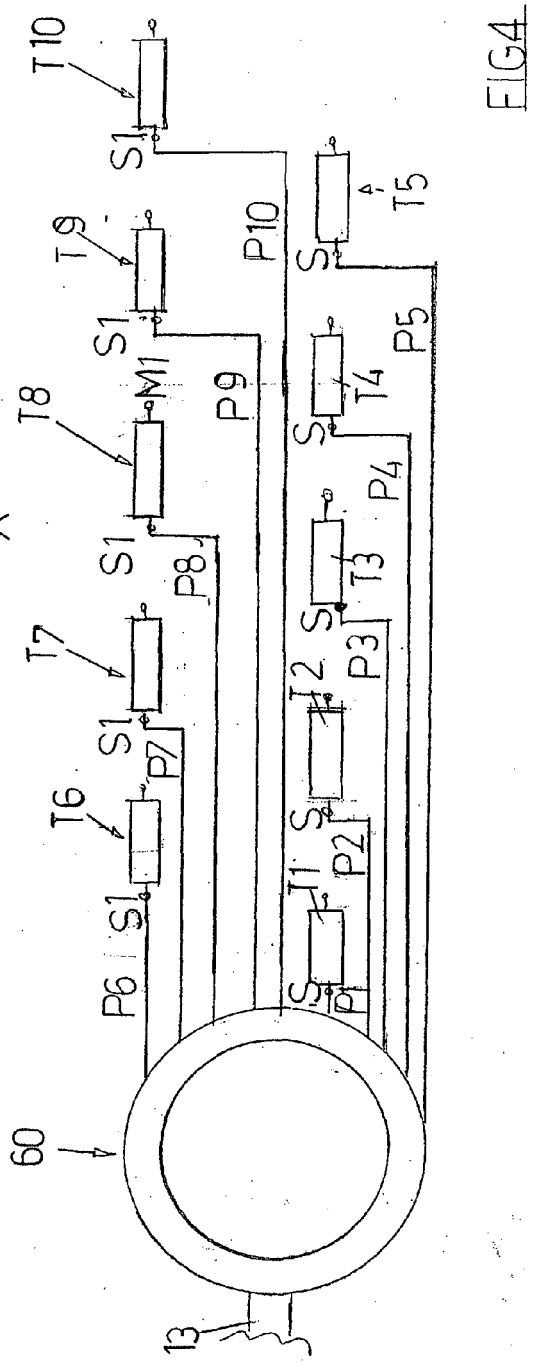
FIG.3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60
13

FIG4

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EUROPEAN SEARCH REPORT

Application Number
EP 15 17 1930

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	US 2011/242156 A1 (SHIMODA TOMOHIKO [JP]) 6 October 2011 (2011-10-06) * paragraphs [0057] - [0059], [0069]; figures 5,7 *	1-10	INV. B41J2/175 B41J2/18
A	WO 2010/118225 A1 (PLASTIPAK PACKAGING INC [US]; UPTERGROVE RONALD L [US]) 14 October 2010 (2010-10-14) * paragraph [0015]; claim 8; figure 1 *	1-10	
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TECHNICAL FIELDS SEARCHED (IPC)

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