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

(11) **EP 4 442 883 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
09.10.2024 Bulletin 2024/41

(21) Application number: **24167756.6**

(22) Date of filing: **28.03.2024**

(51) International Patent Classification (IPC):
D06B 5/26 *(2006.01)* ***D06B 23/20*** *(2006.01)*
D06B 5/24 *(2006.01)* *D06B 23/14* *(2006.01)*

(52) Cooperative Patent Classification (CPC):
D06B 5/26; D06B 23/205; D06B 5/24; D06B 23/14

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

(30) Priority: **06.04.2023 IT 202300006750**

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(54) **APPARATUS AND METHOD FOR THE TREATMENT OF TEXTILE ARTICLES**

(57) The present invention concerns an apparatus for the treatment of textile articles, in particular garments. More in detail, the present invention concerns, in a non-limiting application example, an apparatus for the reduction and controlled oxidation particularly suitable for indigo dyeing.

Furthermore, the present invention also concerns a method for treating textile articles, in particular garments, with the aforementioned apparatus.

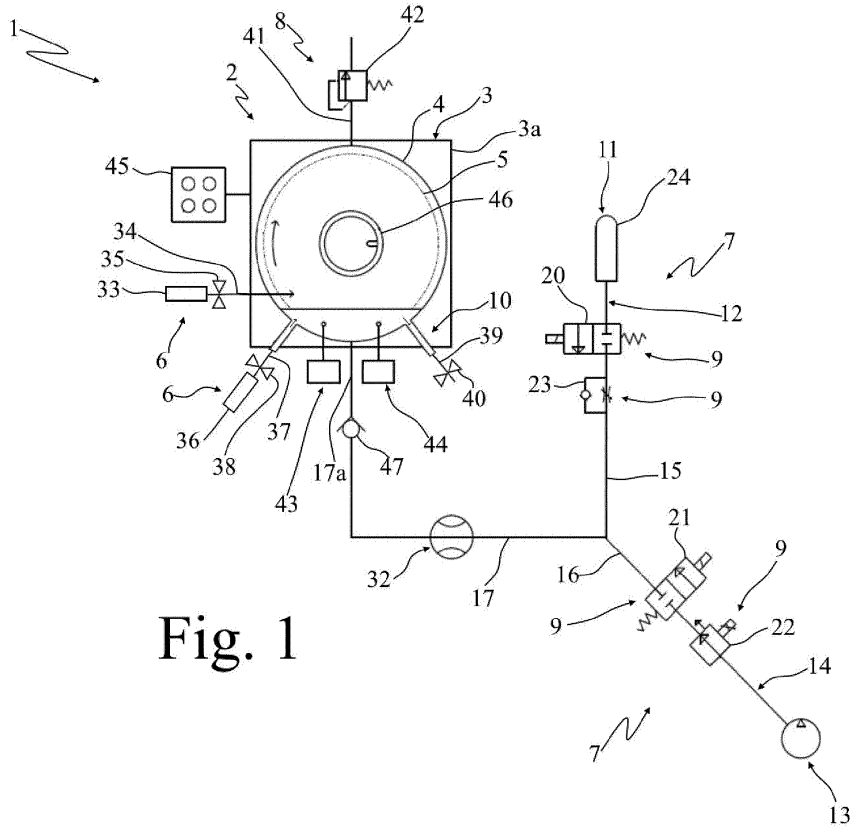

Fig. 1

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention concerns an apparatus for the treatment of textile articles, in particular garments. More in detail, the present invention concerns, in a non-limiting application example, an apparatus for the reduction and controlled oxidation particularly suitable for indigo dyeing.

[0002] Furthermore, the present invention also concerns a method for treating textile articles, in particular garments, with the aforementioned apparatus.

STATE OF THE PRIOR ART

[0003] The sector of industrial apparatuses for the treatment of textile articles is constantly evolving thanks to research and technological innovation.

[0004] In this context, with particular reference to the field of dyeing, the use of dyeing components, for example indigo, finds an important use in the dyeing of denim fabric, commonly used for the production of garments such as jeans, jackets, shirts, skirts and similar. This fabric, in fact, lends itself excellently to finishing treatments, such as, for example, stonewash, bleaching, decolorization or decoration using LASER and similar, particularly appreciated as it is capable of creating authentic and vintage looks by exploiting the dyeing components applied to denim fabric.

[0005] The current state of the art regarding the dyeing treatment of textile articles, in particular garments, with particular reference to indigo garment dyeing, still requires a large use of manpower and is characterized by low productivity. In this regard, whether the dyeing component is a pigment of natural origin such as, for example, natural indigo or woad, or whether the dyeing component is of industrial synthesis, the manual and repeated immersion of the textile articles in large tanks, the constant control of the dye bath and a long final step of drying the textile articles in the air which allows, by means of oxidation, the fixing of the dyeing component are required.

[0006] As can be understood, the exposure of textile articles to the air during final drying does not allow to control or regulate the oxidation of the dyeing component, which, instead, has a considerable impact on the mechanical and/or final physical properties of the textile article as well as on the reproducibility and productivity of the treatment.

[0007] Another aspect worth mentioning is the large quantity of reducing chemical components used in the apparatus and related dyeing processes provided in the state of the art. In this sense, the need is felt to modify existing dyeing methods by turning them towards more sustainable and advanced production practices.

[0008] It is therefore necessary and advantageous to design and create an apparatus and a respective method that uses this apparatus which allow the disadvantages of the known art listed above to be overcome.

OBJECTS OF THE INVENTION

[0009] The technical aim of the present invention is therefore to improve the state of the art in the sector of apparatus and respective methods for the treatment of textile articles, in particular garments.

[0010] An object of the present invention is to provide an apparatus and a respective method which allow to control or regulate the reduction and oxidation of at least one dyeing component in a textile article dyeing machine.

[0011] Another object of the present invention is to develop an apparatus and a respective method that allow the use of products or substances harmful to the environment to be reduced.

[0012] A further object of the present invention is to provide an apparatus and a respective method which allow the dyeing process of textile articles to be speeded up and reproduced in an industrial manner, effectively increasing its productivity.

[0013] Yet another object of the present invention is to provide an apparatus and a respective method which allow the chemical-physical reactions of the dye to be assisted.

[0014] Another object of the present invention is to develop an apparatus and a respective method which facilitate the subsequent application of finishing treatments to dyed textile articles.

[0015] Finally, yet another object of the present invention is to provide an apparatus and a respective method which allow the improvement of the reproducibility of dyed textile articles.

[0016] This aim and these objects are achieved by an apparatus for the treatment of textile articles according to claim 1.

[0017] This aim and these objects are also achieved by a method for the treatment of textile articles according to claim 19.

[0018] The dependent claims refer to preferred and advantageous embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Other features and advantages of the invention will be more evident from the description of an embodiment of a machine for the treatment of textile articles, in particular garments, illustrated for indicative purposes in the attached drawings in which:

- figure 1 schematically illustrates an apparatus for the treatment of textile articles, in particular garments, according to a first embodiment of the present invention,
- figure 2 schematically illustrates an apparatus for the treatment of textile articles, in particular garments, according to a second embodiment of the present invention,

- figure 3 schematically illustrates an apparatus for the treatment of textile articles, in particular garments, according to a third embodiment of the present invention,
- figure 4 schematically illustrates an apparatus for the treatment of textile articles, in particular garments, according to a fourth embodiment of the present invention,
- figure 5 schematically illustrates an apparatus for the treatment of textile articles, in particular garments, according to a fifth embodiment of the present invention, and
- figure 6 schematically illustrates an apparatus for the treatment of textile articles, in particular garments, according to a sixth embodiment of the present invention.

[0020] In the attached drawings, identical parts or components are identified by the same reference numbers.

EMBODIMENTS OF THE INVENTION

[0021] With reference to the attached figures, the reference number 1 indicates as a whole an apparatus for the treatment of textile articles, in particular garments, according to a first non-limiting embodiment of the present invention.

[0022] With "textile article" it is intended any object made of fabric, the latter being of either natural, vegetable or animal origin or artificial, for example trousers such as jeans, shorts, sweaters, t-shirts, sweatshirts, socks, skirts, shirts, jackets, hats or similar. In this regard, it is specified that a textile article could also simply be a piece of fabric, however, the apparatus according to the present invention is particularly suitable and advantageous for the treatment of finished garments.

[0023] In particular, as will be seen from the following description, the apparatus according to the present invention is particularly suitable and advantageous for use in dyeing, and in the controlled reduction and oxidation of one or more textile articles, in particular garments, advantageously finished garments.

[0024] The apparatus 1 for the treatment of textile articles, in particular garments, according to the present invention comprises a dyeing machine 2 which includes a frame 3, a containment tank 4, operatively connected to the frame 3, configured to contain, in use, a dye bath and a shaking component or basket 5, mounted rotatable or movable within the containment tank 4 and in fluid communication with the latter, configured to contain, in use, one or more textile articles.

[0025] The apparatus 1 according to the present invention then includes introduction means 6 configured to introduce or allow the introduction of at least one liquid component and at least one dyeing component of a dye bath in a first time into the dyeing machine 2 or of at least a liquid component of a dye bath in a first time and at least one dyeing component of a dye bath in a fifth time, comprised between the first time and a second time or comprised between a second time and a fourth time, in the dyeing machine 2, injection means 7 configured to inject or allow the injection of a first inert gas or, in any case, a gas non-reactive with the dye bath and of a second gas comprising or consisting of oxygen in the dyeing machine 2, expulsion means 8 configured to expel gas from the dyeing machine 2, adjustment means 9 configured to adjust or control the injection of the first inert gas in a or in the second time following the first time and of the second gas comprising or consisting of oxygen in a third time following the second time in the dyeing machine 2, and discharging means 10 configured to discharge liquid at least in a or in the fourth time following the second time and preceding the third time from the dyeing machine 2.

[0026] In other words, the at least one dyeing component can be introduced into the dyeing machine 2 by means of the introduction means 6 with the at least one liquid component in the first time or separately from the latter before the injection, by means of the injection means 7, of the first inert gas or after the injection, by means of the injection means 7, of the first inert gas but clearly before discharging the dye bath in the fourth time by means of the discharging means 10, as will be evident from the description of the method according to the present invention reported afterwards.

[0027] It should be noted that, with reference to the terminology "first time, second time, third time, fourth time and fifth time", they are to be considered as time intervals since these actions cannot be carried out instantly.

[0028] So far as the frame 3 is concerned, it advantageously comprises delimiting walls 3a to which the containment tank 4 can be operatively associated, for example fixed or connected, for example by means of suitable connecting means, such as screws, bolts, rivets and/or the like or, alternatively, the containment tank 4 can be made in one piece with the frame 3.

[0029] The term "fixed" means that the containment tank 4 cannot be moved or removed from the frame 3 unless the connecting means between them are dismantled, such as screws, bolts, rivets and/or the like, if provided.

[0030] Clearly, in use, an oscillation, if desired cushioned, of the containment tank 4 with respect to the frame 3 can be provided, for example in the case in which the containment tank 4 is fixed or connected to the frame 3 by means of special springs used as connecting means.

[0031] If desired, in this case, the containment tank 4 can be cushioned, for example from below, by means of special cushioning means included in the dyeing machine 2.

[0032] From a construction point of view, the frame 3 can be made of metallic material, for example steel or iron, if desired, also of rigid plastic material.

[0033] Similarly, the containment tank 4 can also be made of metallic material, for example steel, if desired, also of rigid plastic material.

[0034] In the same way, the shaking component or basket 5 can also be made of metallic material, for example steel, if desired, also of rigid plastic material.

[0035] With regard to the latter, it preferably includes or defines a dyeing chamber configured, in use, to house one or more textile articles.

[0036] Advantageously, the shaking component or basket 5 delimits one or more transfer openings or comprises one or more transfer ducts configured to place the dyeing chamber and the containment tank 4 in fluid communication.

[0037] Preferably, the dyeing machine 2 also includes movement means configured to move or rotate the shaking component or basket 5 as well as actuation means of the movement means, for example an electric motor.

[0038] The movement means can be any component or system suitable for moving or rotating the shaking component or basket 5.

[0039] For example, the movement means could comprise a first shaft, connected integrally in rotation, for example keyed, with the shaking component or basket 5, a first pulley or driven pulley, connected integrally in rotation, for example keyed, with the first shaft, a second shaft which, in use, can be operated in rotation by the actuation means, a second pulley or driving pulley, connected integrally in rotation, for example keyed, with the second shaft, and a transmission element or belt configured to transmit motion from the second pulley or driving pulley to the first pulley or driven pulley.

[0040] Preferably, the dyeing machine 2 also includes a closing component or door 46, connected to the frame 2, movable or displaceable between an opening position in which it defines an access opening to the shaking component or basket 5 or, better, to the dyeing chamber delimited by it, and a closing position in which it hermetically closes such access opening, for example by controlling a suitable solenoid valve operatively associated with locking means of the closing component or door 46.

[0041] With reference to the introduction means 6, they preferably comprise a first font 33 of at least one dyeing component of the dye bath, a first conveying conduit or line 34, for example a first tubing, for at least one dyeing component of the dye bath having an end proximal to the dyeing machine 2 in fluid communication with the latter and an end distal from the dyeing machine 2 in fluid communication with the first font 33, and a first inflow valve 35, operatively associated with, for example placed to intercept, the first conveying conduit or line 34, movable or displaceable between a closed position which prevents the conveyance of at least one dyeing component into the dyeing machine 2 and at least one opened position which allows the conveyance of at least one dyeing component into the dyeing machine 2 as well as a second font 36 of at least one liquid component of the dye bath, a second conveying conduit or line 37, for example a second tubing, for at least one liquid component of the dye bath having an end proximal to the dyeing machine 2 in fluid communication with the latter and an end distal from the dyeing machine 2 in fluid communication with the second font 36, and a second inflow valve 38, operatively associated with, for example placed to intercept, the second conveying conduit or line 37, movable or displaceable between a closed position which prevents the conveyance of at least one liquid component of the dye bath into the dyeing machine 2 and at least one opened position which allows the conveyance of at least one liquid component of the dye bath into the dyeing machine 2.

[0042] Alternatively, the introduction means 6 can comprise a main font of at least one dyeing component and at least one liquid component of the dye bath, a conveying conduit or line for at least one dyeing component and for at least one liquid component of the dye bath having an end proximal to the dyeing machine 2 in fluid communication with the latter and an end distal from the dyeing machine 2 in fluid communication with the main font, and an inflow valve, operatively associated with, for example placed to intercept, such conveying conduit or line, movable or displaceable between a closed position which prevents the conveyance of at least one dyeing component and at least one liquid component of the dye bath into the dyeing machine 2 and at least one opened position which allows the conveyance of at least one dyeing component and at least one liquid component of the dye bath in the dyeing machine 2.

[0043] Optionally, the inflow valves 35, 38 can each be a type of valve suitable for selectively allowing or preventing the inflow of at least one liquid component and/or of at least one dyeing component of the dye bath, for example a ball valve, a butterfly valve, a diaphragm valve, a globe valve, a needle valve, a two or more-way valve or similar.

[0044] Preferably, the first font 33 or the main font also includes secondary fonts of one or more auxiliary dyeing components and/or of one or more reducing chemical components.

[0045] From a construction point of view, the first font 33 can advantageously be or comprise a first storage tank which contains the at least one dyeing component, preferably, the one or more auxiliary dyeing components and, if desired, also the one or more reducing chemical components, for example each contained in a respective compartment or container of the first storage tank, if desired served by a respective tubing in fluid communication with the end of the first conveying conduit or line 34 distal from the dyeing machine 2, as well as one or more valves to regulate its delivery.

[0046] The second font 36, instead, can advantageously be or comprise a second storage tank, which contains the at least one liquid component of the dye bath, in fluid communication with the end of the second conveying conduit or line 37 distal from the dyeing machine 2 or it can be or include a dispensing point or source of at least one liquid component of the dye bath, preferably water, deriving from the plant in which the apparatus 1 is installed or positioned, this dispensing point or source of at least one liquid component being in fluid communi-

cation with the end of the second conveying conduit or line 37 distal from the dyeing machine 2.

[0047] Alternatively, the main font, if provided, can advantageously be or comprise a storage tank containing the at least one dye component and the at least one liquid component of the dye bath, preferably, the one or more auxiliary dyeing components and, if desired, also the one or more reducing chemical components, for example each contained in a respective compartment or container of the storage tank, if desired served by a respective tubing in fluid communication with the end of the first conveying conduit or line 34 distal from the dyeing machine 2, as well as one or more valves to regulate its delivery.

[0048] Alternatively, the main font may not include the at least one liquid component in the storage tank but include a dispensing point or source of the at least one liquid component of the dye bath, preferably water, deriving from the plant in which the apparatus 1 is installed or positioned, this dispensing point or source of at least one liquid component being in fluid communication with the second conveying conduit or line 37 distal from the dyeing machine 2, possibly together with a valve to regulate its delivery.

[0049] In relation to the one or more auxiliary dyeing components, they can be, for example, one or more lubricating, detergent, anti-sticking, acid donor, sequestering, leveling, wetting, anti-foaming and/or similar components.

[0050] The reducing chemical components can instead be caustic soda and/or sodium carbonate and/or similar and can be advantageously used to speed up the absorption of the at least one dyeing component by the fibers of the one or more textile articles, during use, inside the dyeing machine 2 or, better, inside the shaking component or basket 5.

[0051] The at least one dyeing component supplied can be an artificial colorant, for example industrially synthetic, or a natural colorant, for example a pigment.

[0052] Advantageously, the at least one dyeing component of the dye bath is an indigo dye, for example a woad pigment, or an industrially synthesized indigo dye, although in the apparatus according to the present invention other different types and/or natures of dye, for example sulfur dyes, Altino dyes, Vat dyes and/or similar could be used. It should be noted that this list is not exhaustive, as different types of dyes that can potentially be used for dyeing one or more textile articles are present both in nature and in the industrial sector.

[0053] If desired, the at least one dyeing component is a pre-reduced colorant, i.e., a colorant chemically reduced to a water-soluble form. In this sense, pre-reduction makes the dye more soluble in water, allowing better penetration into the fibers of the one or more textile articles to be dyed during the dyeing process.

[0054] In particular, the at least one dyeing component can be introduced into the dyeing machine 2 in liquid form or in solid form, for example in powder, into the at least one liquid component of the dye bath.

[0055] So far as the at least one liquid component of the dye bath is concerned, it is preferably water.

[0056] With reference to the injection means 7, they preferably comprise at least a first source 11 of a first inert gas and a first supply duct or line 12 of the first gas, for example a tubing, the first supply duct or line 12 being in fluid communication at a first end thereof with the dyeing machine 2 and at a second end thereof with the first source 11 and/or at least a second source 13 of a second gas comprising or consisting of oxygen and at least a second supply duct or line 14 of the second gas, for example a tubing, the second supply duct or line 14 being in fluid communication at a first end thereof with the dyeing machine 2 and at a second end thereof with the second source 13.

[0057] Preferably, the injection means 7 or, in particular, the first supply duct or line 12 and the second supply duct or line 14 are connected in a portion proximal to, for example about 5, 10, 20 or 30 cm from, the top of the dyeing machine 2 or, better yet, of the containment tank 4.

[0058] Advantageously, the at least one first source 11 includes at least one containment component 24 of the first gas and/or at least one generation unit 25 of the first gas.

[0059] In this regard, according to the non-limiting embodiments of the present invention shown in figures 1, 2, 5 and 6, the at least one first source 11 includes at least one containment component 24 of the first gas.

[0060] In particular, the at least one containment component 24 can advantageously comprise one or more cylinders or tanks containing the first gas.

[0061] According to the non-limiting embodiments of the present invention shown in figures 3, 4, 5 and 6, the at least one first source 11 includes at least one generation unit 25 of the first gas.

[0062] According to the non-limiting embodiments of the present invention shown in figures 5 and 6, the at least one first source 11 includes both at least one containment component 24 of the first gas and at least one generation unit 25 of the first gas.

[0063] The non-limiting embodiments of the present invention illustrated in figures 1 and 2 have the advantage of giving the apparatus a lower implementation cost and a lower architectural complexity compared to the examples illustrated in figures 3 to 6. In such examples, however, they require careful control of the quantity of first gas available in the at least one containment component 24 in order to correctly complete the dyeing process.

[0064] The non-limiting embodiments of the present invention illustrated in figures 3 and 4 have the advantage of not having to depend on the supply of the first gas from at least one containment component 24 and, therefore, of being able to always supply a quantity of first gas without having to control the quantity of the latter available. In such examples, however, the cost of implementing the apparatus 1 increases and in the event of a malfunction of the generation unit 25, its activity and productivity could be compromised.

[0065] The non-limiting embodiments of the present invention illustrated in figures 5 and 6 provide, at the price of increased cost and increased architectural complexity, the best alternative from the point of view of the overall robustness of the apparatus, since in the event of malfunction of the generation unit 25 the at least one containment component 24 could be used for the supply of the first gas. Substantially, in such non-limiting embodiments, the at least one containment component 24 of the first gas and the at least one generation unit 25 of the first gas can be used to replace one another or, if desired, even in combination.

[0066] With reference to this last aspect, if necessary or desired, in the non-limiting embodiments of the present invention illustrated in figures 5 and 6, the at least one containment component 24 could also be used in combination with the at least one generation unit 25 as an auxiliary component in order to increase the supply speed of the first gas in the dyeing machine 2.

[0067] With reference to the first inert gas or, in any case, with the gas non-reactive with the dye bath, it is preferably nitrogen, advantageously pressurized, if desired with a content between 90% and 100%, since it is inexpensive and easily available, however, any gas inert or non-reactive with the dye bath could be used, for example argon, helium, neon or another noble gas.

[0068] Preferably, the first gas has a higher density than the gas present in the dyeing machine 2 before its injection, typically atmospheric air entering during the insertion of one or more textile articles into the dyeing machine 2 or, better, into the dyeing chamber of the shaking component or basket 5, so that this gas present in the dyeing machine 2 before the injection of the first gas can be easily expelled by means of the expulsion means 8 during the injection of the first gas.

[0069] So far as the at least one generation unit 25 is concerned, it can advantageously include an air source 26, preferably compressed air, and an extraction component or unit 27, positioned downstream of the air source 26, configured to receive, in use, the air as an input, extract the first gas from such air and supply it as an output.

[0070] Optionally, the air source 26 is a compressor or a compressed air supply point or source deriving from the plant in which the apparatus 1 is installed or positioned.

[0071] Preferably, the extraction component or unit 27 is a first gas generator capable of separating the molecules of the first gas from the other molecules present in the air, for example a membrane, adsorption, pressure separation or cryogenics first gas generator.

[0072] Advantageously, the generation unit 25 includes an accumulation tank 28 of the first gas positioned downstream of the extraction unit or component 27.

[0073] With reference to this aspect, the accumulation tank 28 can be used in the event that the maximum flow generated by the extraction unit or component 25 is not able to provide a sufficient quantity of first gas in the dyeing machine 2 within a given time or time interval.

[0074] Considering, by way of example, the need to inject a given quantity of first gas into the dyeing machine in a given time, for example about 5 minutes, in passive phases of the extraction unit or component 25, i.e., when the latter must not inject the first gas into the dyeing machine 2, it is possible to accumulate the first gas in the accumulation tank 28 so that during the active phases of the same, i.e., when the latter must inject the first gas into the dyeing machine 2, it is possible with the help of the accumulation tank 28 to provide a flow of first gas capable of satisfying the pre-established injection time requirements.

[0075] Optionally, the generation unit 25 includes at least one filter 29 of the dust present in the air exiting the air source 26.

[0076] Optionally, the air source 26 is a compressed air source 26 and the generation unit 25 also includes a filter 30 of the oil present in the compressed air exiting the compressed air source 26.

[0077] If desired, the generation unit 25 includes drying means 31 of the air exiting the air source 26, for example placed downstream of the filter 30 of the oil, if provided.

[0078] With reference to the drying means 31, they can comprise or be an air dryer, for example a refrigeration, membrane, adsorption, dew point or hot air dryer.

[0079] So far as the second gas comprising or consisting of oxygen is concerned, it is preferably air, advantageously compressed air or oxygen, if desired pressurized.

[0080] Preferably, the second gas has a higher density than the first gas, so that the first gas can be easily expelled from the expulsion means 8 during the injection of the second gas.

[0081] In particular, the at least one second source 13 can advantageously be at least one containment component of the second gas, for example one or more cylinders or tanks, a compressor or a supply point or source of the second gas deriving from the plant in which it is installed or positioned the device 1.

[0082] Regarding the first supply duct or line 12 and the second supply duct or line 14, they comprise, according to the non-limiting embodiments of the present invention shown in figures 1, 3 and 5, respective first branches or lines 15, 16 which convey into a second branch or line 17, common to the first 12 and to the second supply duct or line 14, having a distal end 17a from the first branches or lines 15, 16 in fluid communication with the dyeing machine 2, or, according to the non-limiting embodiments of the present invention shown in figures 2, 4 and 6, respective branches or main lines 18, 19 having a first end in fluid communication with the first source 11 and with the second source 13 respectively and a second end in fluid communication with the dyeing machine 2.

[0083] In relation to the non-limiting embodiment of figures 1, 3 and 5, they reduce the number of components and therefore the overall cost of the apparatus 1 compared to the non-limiting embodiments of figures 2, 4 and

6.

[0084] It should be noted that, during use, the injection of the first and second gas, and therefore the movement of the latter from the respective sources 11, 13 towards the dyeing machine 2, can take place using one of the known gas displacement methodologies, for example by means of compression, convection, diffusion, ventilation or similar.

[0085] With regard to the expulsion means 8, they preferably comprise a gas evacuation duct or line 41 having an end proximal to the dyeing machine 2 in fluid communication with the latter and a gas vent valve 42 operatively associated with, for example placed to intercept, the evacuation duct or line 41.

[0086] Preferably, the expulsion means 8 or, in particular, the evacuation duct or line 41 is connected in a proximal portion to, for example about 5, 10, 20 or 30 cm from, the top of the dyeing machine 2 or, better, of the containment tank 4.

[0087] The expulsion means 8 and, in particular, the evacuation duct or line 41 and the vent valve 42 are advantageously used to expel the gas contained inside the dyeing machine 2 during the injection of the first inert gas and to expel the first inert gas upon injection of the second gas comprising or consisting of oxygen.

[0088] If desired, the expulsion means 8 can also be used to avoid any overpressure inside the dyeing machine 2, for example during the injection of the first inert gas.

[0089] With reference to this aspect, in the event that the pressure inside the dyeing machine 2, for example during the injection of the first gas, were to exceed a set maximum allowed pressure threshold, the expulsion means 8 could advantageously be used to vent part of the gas contained in the dyeing machine 2 to reduce the pressure to the maximum allowed pressure threshold.

[0090] In relation to the adjustment means 9, they preferably comprise a first regulation or shut-off valve 20 of the first gas, operatively associated with said injection means 7, in particular with the first supply duct or line 12, movable or displaceable between a closed position which prevents the first gas from flowing into the dyeing machine 2 and at least one opened position which allows the first gas to flow into the dyeing machine 2, and at least a second regulation or shut-off valve 21 of the second gas, operatively associated with the injection means 7, in particular to the second supply duct or line 14, movable or displaceable between a closed position which prevents the second gas from flowing into the dyeing machine 2 and at least one opened position which allows the second gas to flow into the dyeing machine 2.

[0091] According to the non-limiting embodiments of the present invention shown in figures from 1 to 6, the first 20 and the second regulation or shut-off valve 21 are two-way valves.

[0092] Alternatively, the first 20 and the second regulation or shut-off valve 21 could be another type of valve suitable for allowing or preventing respectively the flow of the first and second gas in the dyeing machine 2, for example a ball valve, a butterfly valve, a diaphragm valve, a globe valve, a needle valve or similar.

[0093] In essence, the first 20 and the second regulation or shut-off valve 21 can be adjusted or controlled so as to allow the injection of the first inert gas in a second time following the first time and of the second gas comprising or consisting of oxygen in a third time following the second time into the dyeing machine 2.

[0094] Thus, for example, when it is necessary to inject the first gas in a second time, the first regulation or shut-off valve 20 is in the opened position while the second regulation or shut-off valve 21 is in the closed position while when it is necessary to inject the second gas in a third time following the second time, the first shut-off valve 20 is in the closed position while the second shut-off valve 21 is in the opened position.

[0095] Consider that, in the non-limiting embodiments of the present invention shown in figures 5 and 6, there being two first regulation or shut-off valves 20, during the injection of the first inert gas in a second time following the first at least one of the same will be in the opened position whereas during the injection of the second gas in the third time following the second, these first regulation or shut-off valves 20 will both be in the closed position.

[0096] Preferably, the apparatus 1 comprises a control panel 45 and an electronic control unit, for example included in the dyeing machine 2, in electrical and/or electronic communication with the control panel 45, configured at least to displace or move the first regulation or shut-off valve 20 and/or the at least one second regulation or shut-off valve 21 from the opened position to the closed position and/or vice versa according to pre-set steps on the control panel 45 and/or according to commands entered by an operator by means of the control panel 45 and/or according to the achievement of given injection volumes of the first and/or second gas in the dyeing machine 2.

[0097] Even more preferably, the electronic control unit is configured to actuate:

- the introduction means 6 in the first time or in the first time and in the fifth time,
- the first regulation or shut-off valve 20 of the first gas in the second time following the first time,
- the second regulation or shut-off valve 21 of the second gas in the third time following the second time, and
- the discharging means 10 in in the fourth time following the second time and preceding the third time.

[0098] In this regard, it is specified that if the introduction means 6 comprise separate conveying conduits or lines 34, 37 for the at least one liquid component and for the at least one dyeing component, the electronic control unit can first activate the first inflow valve 35 and then the second inflow valve 38 or vice versa or they could be

activated simultaneously.

[0099] Advantageously, the adjustment means 9 comprise a pressure regulator 22, for example an electromechanical, if desired electro-pneumatic, pressure regulator 22, configured to regulate or control the pressure of the second gas introduced into the dyeing machine 2.

[0100] Preferably, the pressure regulator 22 is electrically and/or electronically controlled by the electronic control unit by means of the control panel 45.

[0101] From a structural point of view, the pressure regulator 22 is operatively associated with the second supply duct or line 14 downstream of the second source 13, preferably upstream of the second regulation or shut-off valve 21.

[0102] From a construction point of view, the pressure regulator 22 can be, for example, a diaphragm, piston, proportional, two-stage or precision pressure regulator.

[0103] Basically, the pressure regulator 22 allows to control the injection pressure of the second gas.

[0104] Thus, for example, it is possible to increase the pressure of the second gas to speed up the oxidation process of the one or more dyed textile articles while it is possible to decrease it to slow down the oxidation process of the one or more dyed textile articles.

[0105] Furthermore, the adjustment means 9 optionally comprise at least one flow regulator 23 of the first gas, operatively associated with the injection means 7, in particular with the first supply duct or line 12, movable or displaceable between a first gas flow increase position and a first gas flow decrease position.

[0106] Preferably, the at least one flow regulator 23, if provided, is operatively associated with the first supply duct or line 12, for example placed to intercept the latter, downstream of the first regulation or shut-off valve 20.

[0107] With regard to this aspect, the first regulation or shut-off valve 20 has intrinsic losses and, to obtain greater regulation precision, the flow of the first gas is possibly regulated after said first regulation or shut-off valve 20 by means of the flow regulator 23.

[0108] As can be understood, in the non-limiting embodiments of the present invention illustrated in figures 5 and 6, two first sources 11 with respective first regulation or shut-off valves 20 and respective flow regulators 23 are comprised in the apparatus 1.

[0109] It should be noted that the association of a flow regulator to the second supply duct or line 14 of the second gas has not been foreseen since the pressure regulator 22 is optionally already provided, which, indirectly, is also able to regulate the flow of the second gas.

[0110] Regarding this aspect, as is known, the link between flow or flow rate and pressure of a gas is described mathematically by the Bernoulli equation, associated with the Bernoulli effect, which states that in a moving fluid, if the speed of the fluid increases, the pressure decreases and vice versa.

[0111] Clearly, for a more precise regulation of the flow of the second gas introduced into the dyeing machine 2, a respective flow regulator could possibly be provided downstream of the second regulation or shut-off valve 21, even if this addition would increase the overall costs of the apparatus 1.

[0112] So far as the discharging means 10 are concerned, they can optionally comprise at least an outflow duct or line 39 for a liquid having an end proximal to the dyeing machine 2 in fluid communication with the latter and an outflow valve 40, operatively associated with, for example placed to intercept, the outflow duct or line 39, movable or displaceable between a closed position which prevents a liquid from outflowing from the dyeing machine 2 and at least one opened position which allows a liquid to outflow from the dyeing machine 2.

[0113] Preferably, the discharge means 10 or, in particular, the at least one outflow duct or line 39 is connected in a proximal portion to the bottom of the dyeing machine 2 or, better, of the containment tank 4.

[0114] From a construction point of view, the outflow valve 40 can be any valve suitable for selectively preventing or allowing the outflow of a liquid from the dyeing machine 2, for example a ball valve, a butterfly valve, a membrane valve, a globe valve, a needle valve, a two or more-way valve or similar.

[0115] Advantageously, the apparatus 1 includes flow measuring means 32, for example a flow meter, operatively associated with the injection means 7, for example downstream of the regulation or shut-off valves 20, 21, configured to measure the flow of a gas flowing into the dyeing machine 2.

[0116] Preferably, the measuring means 32 are in electrical and/or electronic communication with the electronic control unit. In this way, it is possible to display on the control panel 45 the quantity of gas that is flowing into the dyeing machine 2 to consequently regulate or control, for example opening and/or closing, the regulation or shut-off valves 20, 21, if desired depending on the quantity of gas introduced.

[0117] According to the non-limiting embodiments of the present invention illustrated in figures 2, 4 and 6, a flow meter is provided for each main branch or line 18, 19 while according to the non-limiting embodiments of the present invention illustrated in figures 1, 3 and 5, only one flow meter is provided on the second branch or line 17, common to the first 12 and to the second supply duct or line 14.

[0118] In essence, thanks to the flow measuring means 32, it is possible to obtain and, possibly, display on the control panel 45, the total volume of first and/or second gas introduced into the dyeing machine 2, taking as reference, for example, the passage instant of the first 20 and/or second regulation or shut-off valve 21 into the opened position.

[0119] Preferably, the apparatus 1 includes a non-return valve 47, operatively associated with the injection means 7 at the inlet to the dyeing machine 2, configured, in use, to prevent the dye bath or, in any case, at least a liquid component thereof, to flow into the injection means 7.

[0120] According to the non-limiting embodiments of the present invention shown in figures 2, 4 and 6, a non-return valve 47 is provided for each main branch or line 18, 19 while according to the non-limiting embodiments of the present invention illustrated in the figures 1, 3 and 5, a single non-return valve 47 is provided on the second branch or line 17, common to the first 12 and to the second supply duct or line 14.

[0121] Optionally, the apparatus 1 comprises a measuring component 43 of the reduction potential of the dye bath, for example a potentiostat, operatively associated with the dyeing machine 2, for example with the containment tank 4 or with the shaking component or basket 5, optionally comprising an electrode positioned so as to be in contact with or immersed in the dye bath.

[0122] Optionally, the apparatus 1 also includes a measuring element 44 of the pH of the dye bath, for example a pH meter, operatively associated with the dyeing machine 2, for example with the containment tank 4 or with the shaking component or basket 5, optionally comprising an electrode positioned so as to be in contact with or immersed in the dye bath.

[0123] Advantageously, the apparatus 1 can also include heating and/or cooling means for the dye bath operatively associated with or included in the dyeing machine 2.

[0124] For example, the heating and/or cooling means can be operatively associated with the containment tank 4 and with a recirculation tank or circuit included in the dyeing machine 2, configured to collect and recirculate the dye bath from/into the containment tank 4 and from/into the recirculation tank or circuit.

[0125] More in detail, the heating and/or cooling means can advantageously comprise at least one heat exchanger, for example internal and/or included in the dyeing machine 2 or, if desired, external and/or not included in the latter.

[0126] As can be understood, the apparatus 1 is particularly suitable for use in dyeing, and in the controlled reduction and oxidation of one or more textile articles, in particular garments, advantageously finished garments.

[0127] It is should be noted that, if provided, one, more or all the components used for the control or regulation of the flow and/or pressure of a fluid described in this description, i.e., the valves 20, 21, 35, 38, 40, 42, the at least one flow regulator 23 and/or the pressure regulator 22 can advantageously be controlled electrically and/or electronically by the electronic control unit by means of the control panel 45 while the measuring means, component or element 32, 43, 44 can advantageously be in electrical and/or electronic communication with the electronic control unit so that the latter can provide the values measured by them to the control panel 45 for possible display.

[0128] Furthermore, it should be noted that according to the non-limiting embodiments of the present invention illustrated in the figures, the first gas and the second gas are compressed gases and, therefore, their movement from the respective sources 11, 13 towards the dyeing machine 2 occurs due to the fact that they have a higher pressure than the pressure of the gas that is present in the dyeing machine 2 before their respective injection.

[0129] Subject-matter of the present invention is also a method for treating textile articles, in particular garments, with an apparatus according to the present invention or according to non-limiting embodiments of the present invention.

[0130] The method according to the present invention initially includes the step of inserting one or more textile articles into the dyeing machine 2, advantageously in the dyeing chamber delimited by the shaking component or basket 5 thereof.

[0131] Optionally, the step of putting the shaking component or basket 5 into movement or rotation can be envisaged, if desired at a first movement or rotation speed, for example between about 10 rpm and about 70 rpm, optionally about 40 rpm.

[0132] There is then the step of introducing, by means of the introduction means 6, at least one liquid component, for example water, into the containment tank 4.

[0133] With reference to this, the quantity of the at least one liquid component to be introduced can be defined according to the weight of the one or more textile articles to be dyed, for example between 3 and 40, for example about 10 liters of water per kilogram of textile articles introduced could be used.

[0134] Preferably, after the step of introducing at least one liquid component, the step of introducing, by means of the introduction means 6, one or more auxiliary dyeing components into the containment tank 4 is provided.

[0135] Even more preferably, the method includes the step of heating the liquid present in the dyeing machine 2, for example to a temperature between about 10°C and 60°C, preferably between about 20°C and 50°C, for example about 35°C.

[0136] Advantageously, after the step of introducing at least one liquid component, there is also the step of introducing, by means of the introduction means 6, one or more reducing chemical components into the containment tank 4, for example in a time interval between about 5 minutes and about 30 minutes, if desired about 20 minutes.

[0137] If desired, if the step of putting into movement or rotation has been envisaged, the step of reducing the first movement or rotation speed of the shaking component or basket 5 to a second movement or rotation speed lower than the first can therefore be provided, for example between about 2 and about 60 rpm, optionally between about 5 rpm and about 10 rpm.

[0138] The method according to the present invention then includes the step of injecting, by means of the injection means 7, a first inert gas or, in any case, a gas non-reactive with the dye bath into the containment tank 4 so as to expel, by means of the expulsion means 8, the gas present therein adjusting or controlling the injection of the first gas by means of the adjustment means 9, so

that in the containment tank 4 there is no oxygen or the same is below a threshold value, for example below 10%, preferably below 5%, even more preferably below 3% or 1%.

[0139] Clearly, the first gas injected into the dyeing machine 2 preferably has a higher density than the gas present inside the dyeing machine 2 before its injection. Typically, the gas present in the dyeing machine 2 before the injection of the first gas is atmospheric air entered during the insertion of one or more textile articles. In this sense, the gas present in the dyeing machine 2 before the injection of the first gas can therefore be easily expelled by means of the expulsion means 8 during the step of injecting the first gas.

[0140] Advantageously, the step of injecting can be carried out by introducing a volume of first inert gas between 0.5 and 4 times the volume of the containment tank 4, for example a volume of first inert gas equal to about two times the volume of the containment tank 4, if desired a volume equal to about three times the volume of the containment tank 4. In this injection step, the dyeing machine 2 can be subjected to an overpressure, i.e., a gas pressure inside the dyeing machine 2 which exceeds a preset maximum pressure threshold: in this case the overpressure is managed and controlled by venting part of the gas present inside it by means of the expulsion means 8.

[0141] If desired, this step of injecting the first gas can last between about 2 minutes and about 30 minutes, for example about 15 minutes.

[0142] It should be considered that, advantageously, the injection of a volume of first inert gas between 0.5 and 4 times the volume of the containment tank 4 ensures that all the gas, in general air, present inside the dyeing machine 2 comes out from the latter.

[0143] Subsequently, the step of introducing, before or after the step of injecting the first gas, by means of the introduction means 6, at least one dyeing component into the containment tank 4 so as to generate a dye bath, for example in a time interval between about 2 minutes and about 30 minutes, for example about 15 minutes is comprised.

[0144] The method according to the present invention then includes the step of maintaining the dye bath of the one or more textile articles for a given time, for example for a time interval between about 10 minutes and about 90 minutes, preferably about 50 minutes, so that the dyeing component can act in the absence of oxygen or with oxygen below the threshold value.

[0145] In the step of maintaining, preferably the temperature of the dye bath is kept constant, and if any overpressures occur, part of the gas present inside the dyeing machine 2 is vented through the expulsion means 8, introducing, if necessary, by means of the injection means 7, variable volumes of first gas so as to rebalance these vents.

[0146] Preferably, the step of maintaining includes one or more steps of measuring the pH of the dye bath to verify that the latter is included in a given interval of pH values, for example between about 8.5 and about 13, and/or one or more measurement steps of the reduction potential of the dye bath to verify that the latter is included in a given range of potential values, for example between about -400 mV and about -1100 mV, if desired between about -600 mV and about -900 mV.

[0147] If the step of putting into movement or rotation and the step of reducing has been foreseen, it is advantageously foreseen following the step of introducing at least one dyeing component, if desired following the step of maintaining, the step of increasing the second movement or rotation speed to a third movement or rotation speed, for example equal to the first movement or rotation speed.

[0148] The method according to the present invention therefore involves the step of discharging, by means of the discharging means 10, the dye bath contained in the containment tank 4 and the step of injecting, by means of the injection means 7, a second gas comprising or consisting of oxygen in the containment tank 4 adjusting or controlling the injection of the second gas by means of the adjustment means 9 so as to generate a controlled oxidation of the one or more previously dyed textile articles.

[0149] Clearly, the second gas injected into the dyeing machine 2 preferably has a higher density than the first gas. In this sense, the first gas can therefore be easily expelled by means of the expulsion means 8 during the step of injecting the second gas.

[0150] Advantageously, the step of injecting the second gas can be carried out by introducing a volume of second gas between 0.5 and 10 times the volume of the containment tank 4, for example a volume equal to about four times the volume of the containment tank 4. In this injecting step, the dyeing machine 2 can be subject to an overpressure, i.e., a gas pressure inside the dyeing machine 2 that exceeds a preset maximum pressure threshold: in this case the overpressure is managed and controlled by venting part of the gas present inside it by means of the expulsion means 8.

[0151] If desired, this step of injecting the second gas can last between about 2 minutes and about 30 minutes, for example about 15 minutes.

[0152] Preferably, the step of injecting the second gas includes the step of increasing or reducing the pressure of the second gas by means of a pressure regulator 22 included in the adjustment means 9 so as to speed up or slow down the oxidation of the one or more dyed textile articles.

[0153] It should be noted that with reference to the first and second gas, the at least one liquid component, the at least one dyeing component and, if present, the one or more auxiliary dyeing components as well as the one or more reducing chemical components of the dye bath, what has been said in the description relating to apparatus 1 applies.

[0154] It is specified that in the injection steps of the

first and second gas, the latter can be injected and therefore move from the respective sources 11, 13 into the dyeing machine 2 by means of one of the known methodologies for moving a gas, for example by compression, convection, diffusion, ventilation or similar.

[0155] Furthermore, it should be noted that according to the non-limiting embodiments of the present invention illustrated in the figures, the first gas and the second gas are compressed gases and, therefore, their movement from the respective sources 11, 13 towards the dyeing machine 2 occurs due to the fact that they have a higher pressure than the pressure of the gas which is present in the dyeing machine 2 before the respective injection steps.

[0156] Optionally, following the step of injecting the second gas, one or more rinsing steps of the one or more dyed textile articles and/or a washing step with neutralization of the pH of the one or more dyed textile articles and/or a washing step with fixer of the at least one dyeing component and/or an enzymatic washing step of the one or more textile articles and/or a spinning step of the one or more textile articles can be provided.

[0157] In particular, the one or more rinsing steps can involve the injection of a volume of water, if desired at a temperature between about 10°C and about 60°C, depending on the weight of the one or more textile articles, for example 3 to 40 liters of water could be used for each kilogram of textile articles introduced, and the discharge of the rinsing liquid, for example after a time interval of between about 1 minute and 8 minutes, for example about 3 minutes.

[0158] With reference to the washing step with neutralization of the pH of the one or more dyed textile articles, it can advantageously include the injection of a volume of water depending on the weight of the one or more textile articles, for example about 5 liters of water could be used for each kilogram of textile articles introduced, the heating of the liquid present in the dyeing machine 2 up to a temperature between about 30°C and about 50°C, for example about 40°C, the introduction of acetic acid and/or hydrogen peroxide and/or other oxidizing components by means of the introduction means 6 and finally the discharge of the liquid after a given time interval, for example a time interval between about 2 minutes and about 30 minutes, for example about 15 minutes.

[0159] Regarding the washing step with fixer of the at least one dyeing component, it can optionally include the injection of a volume of water depending on the weight of the one or more dyed textile articles, for example from 3 to 40 liters of water could be used for each kilogram of textile articles introduced, the heating of the liquid present in the dyeing machine 2 up to a temperature between about 10°C and about 60°C, for example about 40°C, the introduction of at least one fixing component in a percentage by weight between about 1% and 15%, preferably between about 2% and about 10%, on the total weight of the one or more textile articles, and finally the discharge of the liquid present in the dyeing machine 2 after a given time interval, for example, a time interval of about 2 minutes to about 30 minutes, for example, about 15 minutes.

[0160] In relation to the enzymatic washing step of the one or more textile articles, if desired it can include the injection of a volume of water depending on the weight of the one or more dyed textile articles, for example about 5 liters of water could be used for each kilogram of textile articles introduced, the heating of the liquid present in the dyeing machine 2 up to a temperature between about 10°C and about 60°C, for example about 40°C, the introduction of at least one enzyme in a percentage by weight between about 0.1% and 30%, preferably between about 1% and about 2%, on the total weight of the one or more textile articles, and finally the discharge of the liquid present in the dyeing machine 2 after a given time interval, for example, a time interval between about 2 minutes and about 30 minutes, for example, about 15 minutes.

[0161] Optionally, one or more further rinsing steps can therefore be provided, for example as described above.

[0162] So far as the possible spinning step of the one or more textile articles is concerned, it can be carried out by bringing the movement or rotation speed of the shaking component or basket 5 to a fourth movement or rotation speed higher than the third movement or rotation speed, for example to a rotation speed between about 100 rpm and about 550 rpm, preferably about 300 rpm.

[0163] Finally, the method according to the present invention includes the step of extracting the one or more textile articles from the dyeing machine 2.

[0164] The apparatus and the respective method according to the present invention allow to control the reduction and oxidation of at least one dyeing component in a textile article dyeing machine.

[0165] Furthermore, the apparatus and method according to the present invention allow the use of products or substances harmful to the environment to be reduced since thanks to the use of the aforementioned controlled reduction and oxidation it is possible to reduce the use of reducing chemical components harmful to the environment.

[0166] Furthermore, the apparatus and method according to the present invention allow the dyeing process of textile articles to be speeded up and industrialized, effectively increasing its productivity, since all those intermediate steps of the traditional processes which required the manual immersion of the textile articles, the constant control of the dye bath and long, uncontrollable intermediate oxidation steps are eliminated.

[0167] It should also be considered that the apparatus and method described above allow the chemical-physical reactions of the dye to be assisted by means of specific mechanical and thermal actions, which actions are considerably more difficult to achieve using traditional apparatus and methods provided in the state of the art.

[0168] Finally, the apparatus and the method according to the present invention also allow to obtain dyed

textile articles whose subsequent application of finishing treatments is much simpler and more effective as well as the improvement of the reproducibility of the dyed textile articles, a direct consequence of the possibility to control or regulate the oxidation.

[0169] It has thus been seen how the invention fully achieves the proposed objects.

[0170] Modifications and variations of the invention are possible within the scope of protection defined by the claims.

Claims

1. Apparatus (1) for the treatment of textile articles, in particular garments, comprising:

   - a dyeing machine (2) which includes a frame (3), a containment tank (4), operatively connected to the frame (3), configured to contain, in use, a dye bath and a shaking component or basket (5), mounted rotatable or movable within the containment tank (4) and in fluid communication with the latter, configured to contain, in use, one or more textile articles,
   - introduction means (6) configured to introduce or allow the introduction of at least one liquid component and at least one dyeing component of a dye bath in a first time into said dyeing machine (2) or of at least one liquid component of a dye bath in a first time and at least one dyeing component of a dye bath in a fifth time, comprised between the first time and a second time or comprised between a second time and a fourth time, in said dyeing machine (2),
   - injection means (7) configured to inject or allow the injection of a first inert gas and a second gas comprising or consisting of oxygen into said dyeing machine (2),
   - expulsion means (8) configured to expel gas from said dyeing machine (2),
   - adjustment means (9) configured to adjust or control the injection of the first inert gas in a or in said second time following the first time and of the second gas comprising or consisting of oxygen in a third time following said second time into said dyeing machine (2), and
   - discharging means (10) configured to discharge liquid at least in a or in said fourth time following the second time and preceding the third time from said dyeing machine (2).

2. Apparatus according to the preceding claim, wherein said adjustment means (9) comprise:

   - a first regulation or shut-off valve (20) of the first gas, operatively associated with said injection means (7), movable or displaceable between a closed position which prevents the first gas from flowing into said dyeing machine (2) and at least an opened position allowing the first gas to flow into said dyeing machine (2), and
   - at least one second regulation or shut-off valve (21) of the second gas, operatively associated with said injection means (7), movable or displaceable between a closed position which prevents the second gas from flowing into said dyeing machine (2) and at least one opened position which allows the second gas to flow into said dyeing machine (2).

3. Apparatus according to the preceding claim, comprising a control panel (45) and an electronic control unit, in electrical and/or electronic communication with said control panel (45), configured at least to displace or move said first regulation or shut-off valve (20) and/or said at least one second regulation or shut-off valve (21) from said opened position to said closed position and/or vice versa according to preset steps on said control panel (45) and/or according to commands entered by an operator by means of said control panel (45) and/or according to the achievement of given injection volumes of the first gas and/or of the second gas in said dyeing machine (2).

4. Apparatus according to the preceding claim, wherein said electronic control unit is configured to actuate:

   - the introduction means (6) in said first time or in said first time and in said fifth time,
   - the first regulation or shut-off valve (20) of the first gas in said second time following the first time,
   - the second regulation or shut-off valve (21) of the second gas in said third time following the second time, and
   - the discharging means (10) in said fourth time following the second time and preceding the third time.

5. Apparatus according to any one of the preceding claims, wherein said injection means (7) comprise:

   - at least a first source (11) of a first inert gas and a first supply duct or line (12) of the first gas, said first supply duct or line (12) being in fluid communication at a first end thereof with said dyeing machine (2) and at a second end thereof with said first source (11), and/or
   - at least one second source (13) of a second gas comprising or consisting of oxygen and at least one second supply duct or line (14) of the second gas, said second supply duct or line (14) being in fluid communication at a first end thereof with said dyeing machine (2) and at a second

end thereof with said second source (13).

6. Apparatus according to the preceding claim, wherein said first (12) and said at least one second supply duct or line (14) comprise:

- respective first branches or lines (15, 16) which convey into a second branch or line (17), common to said first (12) and to said second supply duct or line (14), having a distal end (17a) from said first branches or lines (15, 16) in fluid communication with said dyeing machine (2), or
- respective main branches or lines (18, 19) having a first end in fluid communication respectively with said first source (11) and said second source (13) and a second end in fluid communication with said dyeing machine (2).

7. Apparatus according to any one of the preceding claims, wherein said adjustment means (9) comprise a pressure regulator (22) configured to regulate or control the pressure of the second gas introduced into said dyeing machine (2).

8. Apparatus according to the preceding claim when dependent on claim 3, wherein said pressure regulator (22) is controlled electrically and/or electronically by said electronic control unit by means of said control panel (45).

9. Apparatus according to any one of the preceding claims, wherein said adjustment means (9) comprise at least one flow regulator (23) of the first gas, operatively associated with said injection means (7), movable or displaceable between a first gas flow increase position and a first gas flow decrease position.

10. Apparatus according to claim 5, wherein said first source (11) comprises at least one containment component (24) of the first gas and/or at least one generation group (25) of the first gas.

11. Apparatus according to the preceding claim, wherein said generation group (25) comprises an air source (26) and an extraction component or unit (27), positioned downstream of said air source (26), configured to receive, in use, air as an input, extract the first gas from such air and supply it as an output.

12. Apparatus according to any one of the preceding claims, comprising flow measuring means (32), operatively associated with said injection means (7), configured to measure the flow of a gas flowing into said dyeing machine (2).

13. Apparatus according to the preceding claim when dependent on claim 3, wherein said measuring means (32) are in electrical and/or electronic communication with said electronic control unit.

14. Apparatus according to any one of the preceding claims, wherein said introduction means (6) comprise:

- a first font (33) of at least one dyeing component of the dye bath, a first conveying conduit or line (34) for at least one dyeing component of the dye bath having an end proximal to said dyeing machine (2) in fluid communication with the latter and a distal end from said dyeing machine (2) in fluid communication with the first font (33), and a first inflow valve (35), operatively associated with said first conveying conduit or line (34), movable or displaceable between a closed position which prevents the conveyance of at least one dyeing component into said dyeing machine (2) and at least one opened position which allows the conveyance of at least one dyeing component into said dyeing machine (2) as well as a second font (36) of at least one liquid component of the dye bath and a second conveying conduit or line (37) for at least one liquid component of the dye bath having an end proximal to said dyeing machine (2) in fluid communication with the latter and a distal end from said dyeing machine (2) in fluid communication with the second font (36), and a second inflow valve (38), operatively associated with said second conveying conduit or line (37), movable or displaceable between a closed position which prevents the conveyance of at least one liquid component of the dye bath in said dyeing machine (2) and at least one opened position which allows the conveyance of at least one liquid component of the dye bath in said dyeing machine (2), or
- a main font of at least one dyeing component and at least one liquid component of the dye bath, a conveying conduit or line for at least one dyeing component and for at least one liquid component of the dye bath having an end proximal to said dyeing machine (2) in fluid communication with the latter and an end distal from said dyeing machine (2) in fluid communication with said main font, and an inflow valve, operatively associated with said conveying conduit or line, movable or displaceable between a closed position which prevents the conveyance of at least one dyeing component and at least one liquid component of the dye bath into said dyeing machine (2) and at least one opened position which allows the conveyance of at least one dyeing component and at least one liquid component of the dye bath in said dyeing machine (2).

15. Apparatus according to any one of the preceding claims, comprising a measuring component (43) of the reduction potential of the dye bath operatively associated with said dyeing machine (2).

16. Apparatus according to any one of the preceding claims, comprising a measuring element (44) of the pH of the dye bath operatively associated with said dyeing machine (2).

17. Apparatus according to any one of the preceding claims, comprising heating and/or cooling means of the dye bath operatively associated with or included in said dyeing machine (2).

18. Apparatus according to any one of the preceding claims for use in dyeing and in the controlled reduction and oxidation of one or more textile articles, in particular garments.

19. Method for treating textile articles, in particular garments, with an apparatus according to any one of the preceding claims, comprising the steps of:

inserting one or more textile articles into the dyeing machine (2),
introducing, by means of the introduction means (6), at least one liquid component into the containment tank (4),
injecting, by means of the injection means (7), a first inert gas into the containment tank (4) so as to expel, by means of the expulsion means (8), the gas present therein adjusting or controlling the injection of the first gas by means of the adjustment means (9), so that in the containment tank 4 there is no oxygen or the same is below a threshold value,
introducing, before or after said step of injecting the first gas, by means of the introduction means (6), at least one dyeing component into the containment tank (4) so as to generate a dye bath,
maintaining the dye bath of one or more textile articles for a given time so that said dyeing component can act in the absence of oxygen or with oxygen below the threshold value,
discharging, by means of the discharging means (10), the dye bath contained in the containment tank (4),
injecting, by means of the injection means (7), a second gas comprising or consisting of oxygen into the containment tank (4) adjusting or controlling the injection of the second gas by means of the adjustment means (9) so as to generate a controlled oxidation of the one or more previously dyed textile articles, and
extracting the one or more textile articles from the dyeing machine (2).

20. Method according to the preceding claim, wherein said step of injecting the second gas comprise the step of increasing or reducing the pressure of the second gas by means of a pressure regulator (22) included in the adjustment means (9) so as to speed up or slow down the oxidation of one or more dyed textile articles.

21. Method according to claims 19 or 20, comprising, after the step of introducing at least one liquid component, the step of introducing, by means of the introduction means (6), one or more auxiliary dyeing components into the containment tank (4).

22. Method according to any one of claims 19 to 21, comprising, after the step of introducing at least one liquid component and before the step of injecting the first gas, the step of introducing, by means of introduction means (6), one or more reduction chemical components in the containment tank (4).

23. Method according to any one of claims 19 to 22, comprising, after the step of introducing at least one liquid component, the step of moving or rotating the shaking component or basket (5) with a first speed of movement or rotation.

24. Method according to the preceding claim, comprising, before the step of injecting the first gas, the step of reducing the first movement or rotation speed to a second movement or rotation speed lower than the first.

25. Method according to the preceding claim, comprising, after the step of introducing at least one dyeing component, the step of increasing the second movement or rotation speed to a third movement or rotation speed.

26. Method according to any one of claims 19 to 25, comprising, after the step of introducing at least one liquid component, the step of heating the liquid present in the containment tank (4).

27. Method according to any one of claims 19 to 26, wherein in said step of maintaining one or more steps of measuring the pH of the dye bath to check that the latter is included in a given interval of pH values and/or one or more steps of measuring the reduction potential of the dye bath to verify that the latter is included in a given interval of potential values are included.

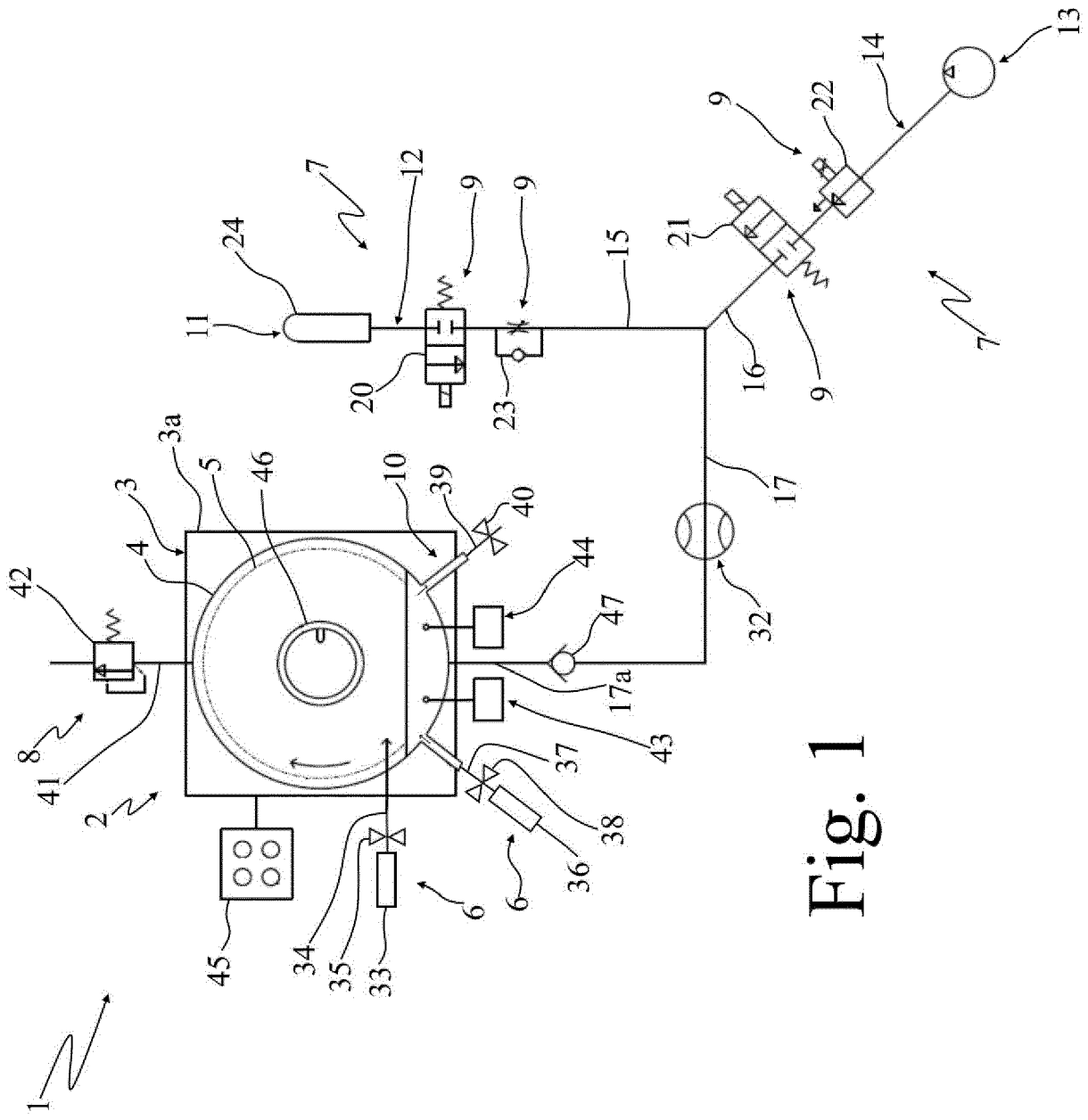
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Fig. 1

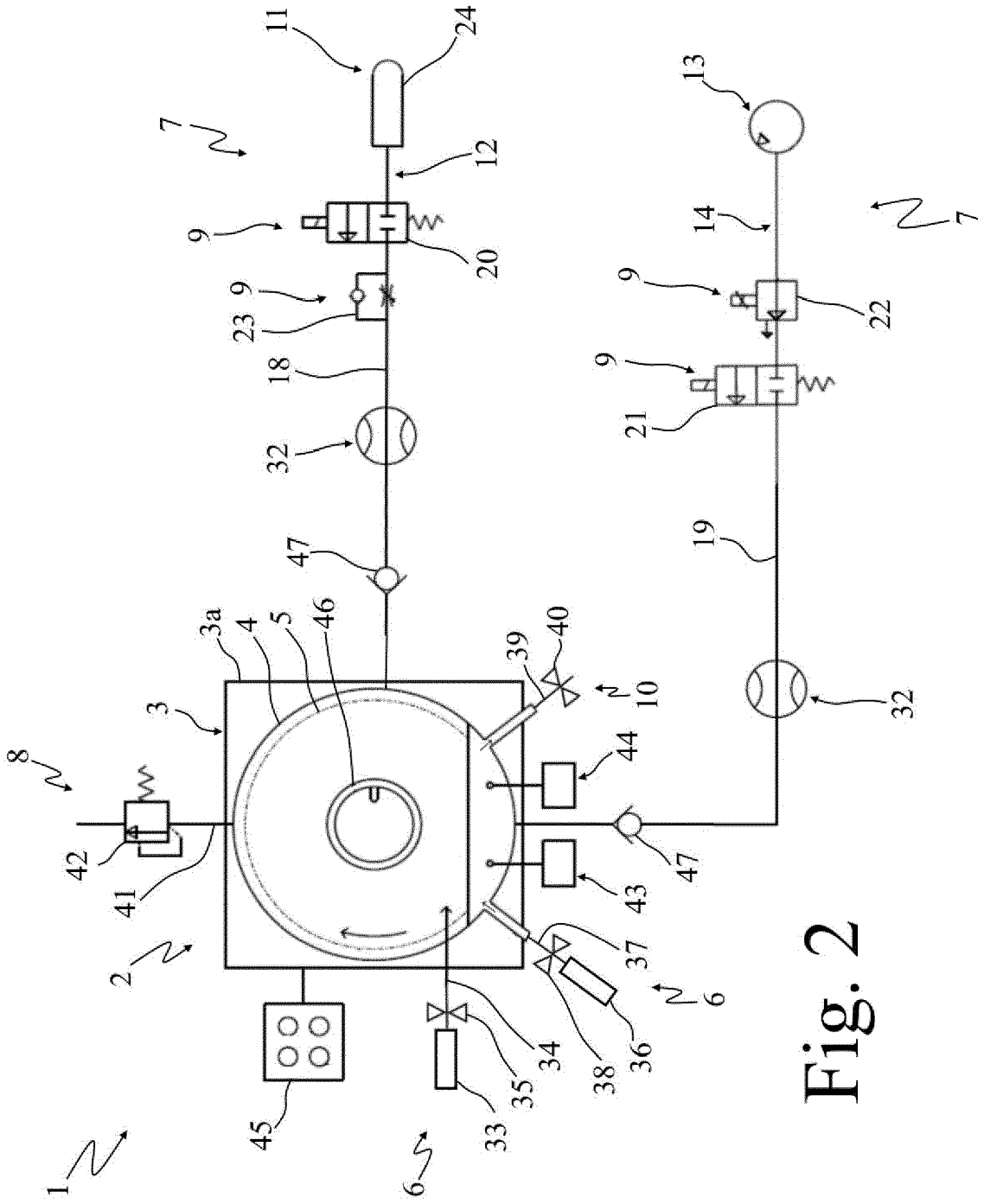
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Fig. 2

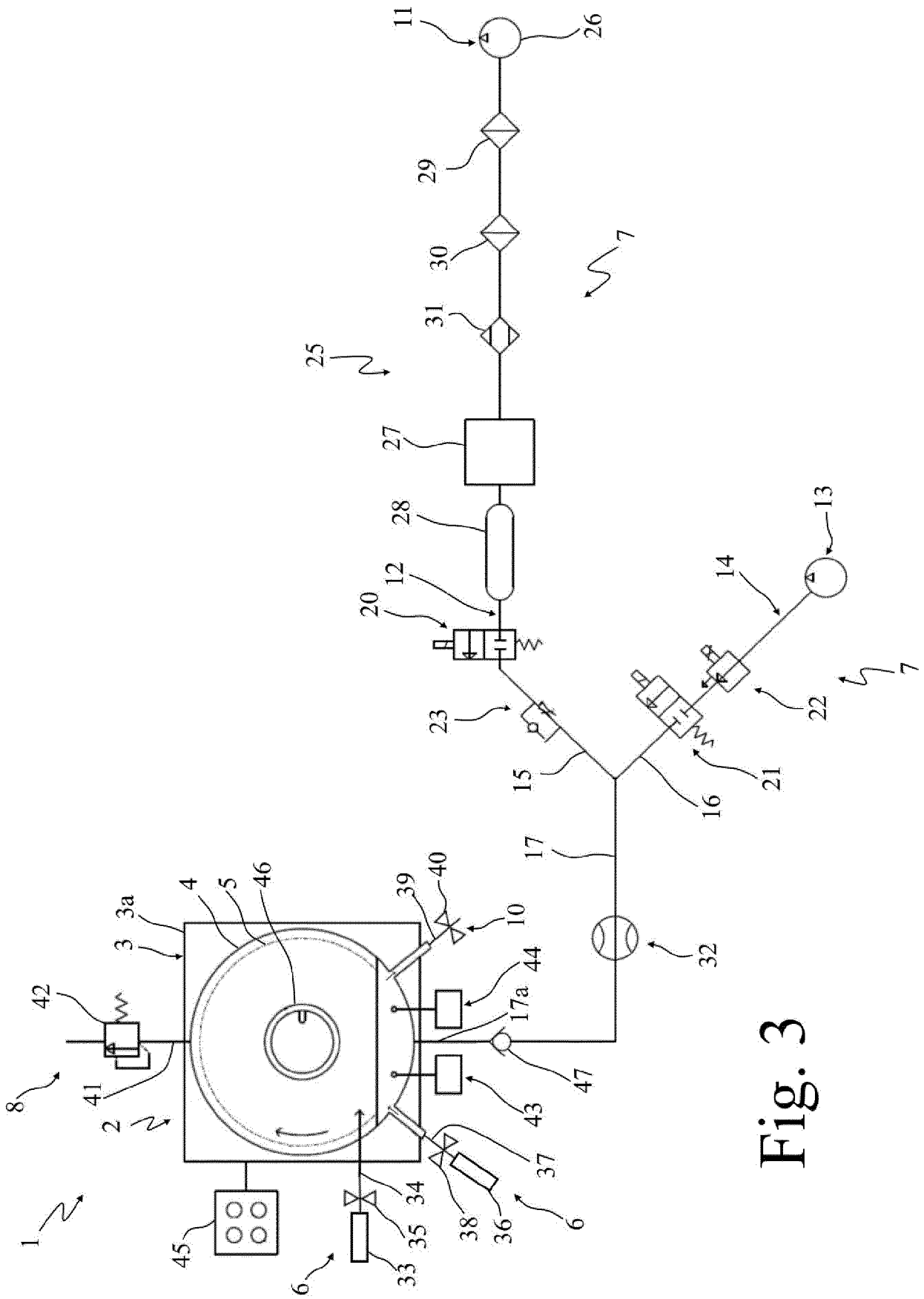
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Fig. 3

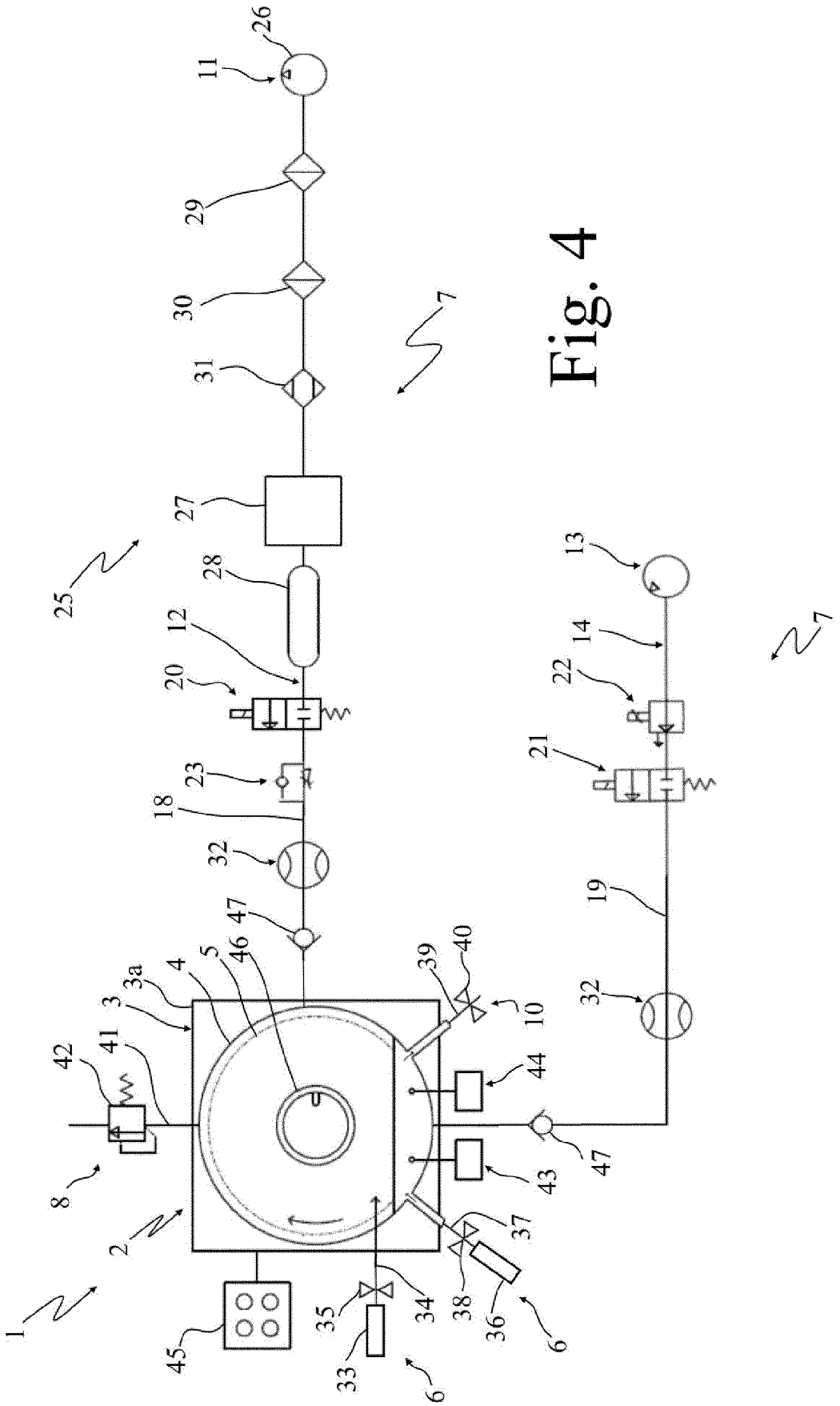
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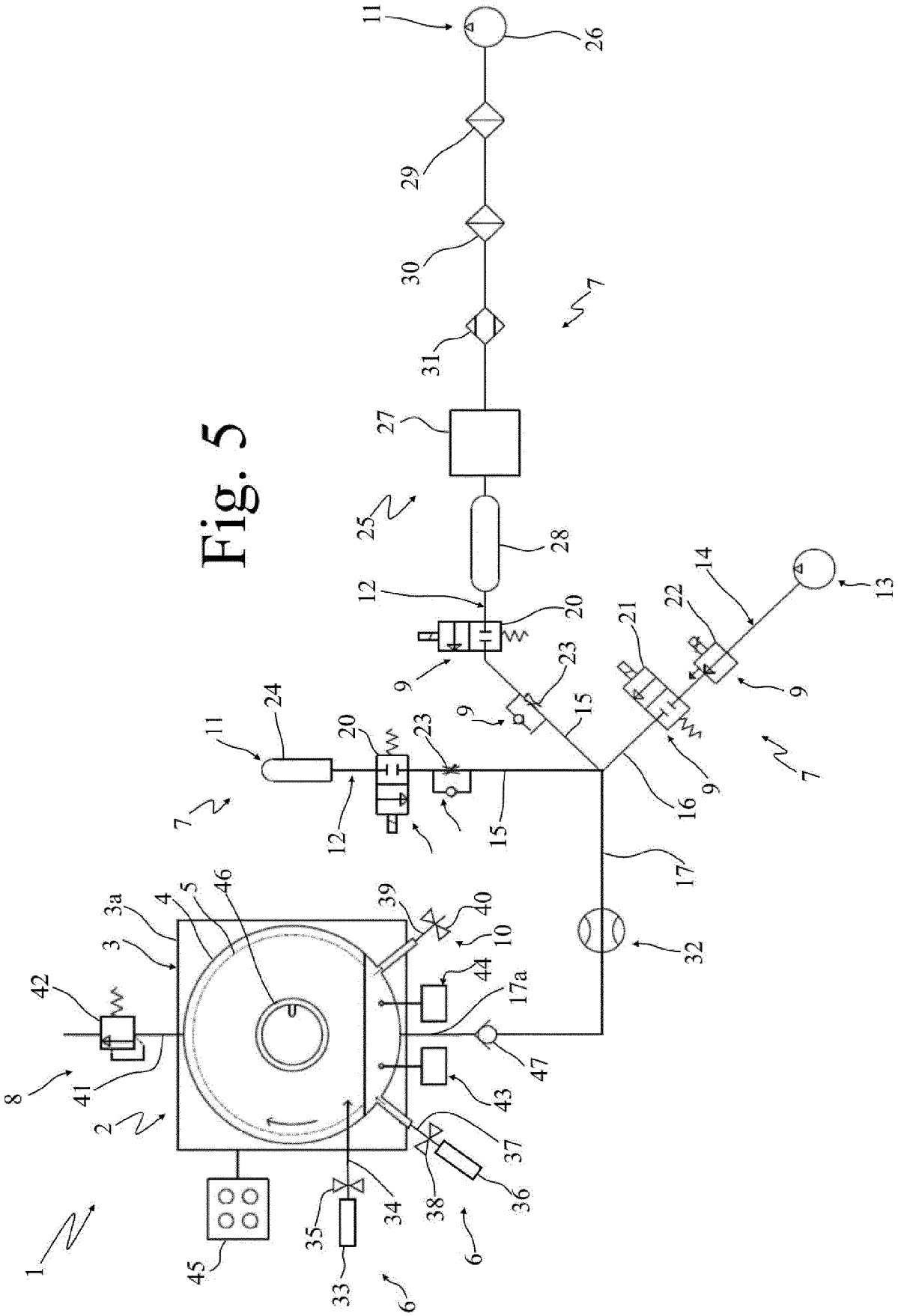
Fig. 4

Fig. 5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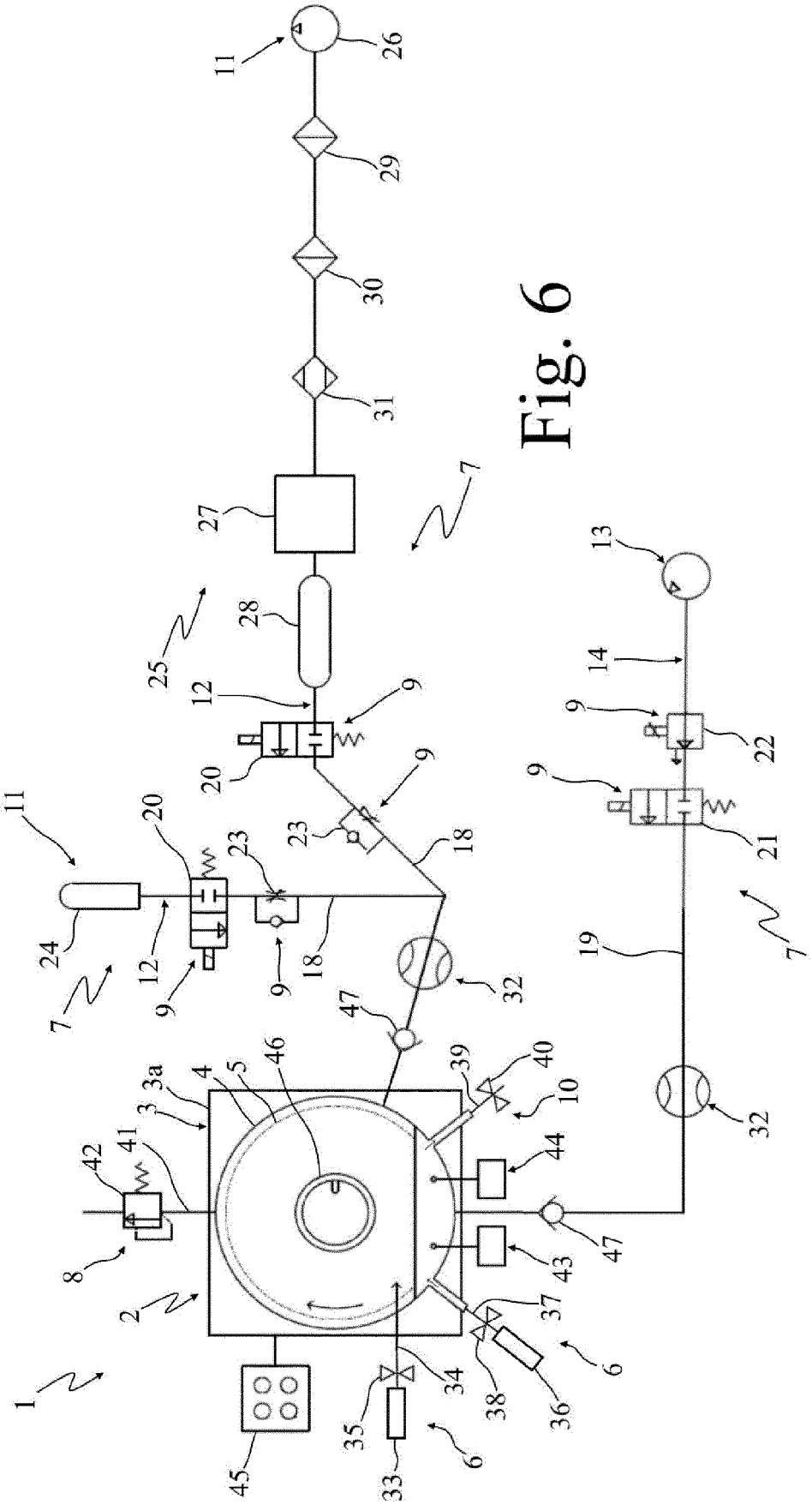
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Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
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D06B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 July 2024	Iamandi, Daniela

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