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CA 2940094 A1 2015/08/27

(21) 2 940 094

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) **Date de dépôt PCT/PCT Filing Date:** 2015/02/02
(87) **Date publication PCT/PCT Publication Date:** 2015/08/27
(85) **Entrée phase nationale/National Entry:** 2016/08/18
(86) **N° demande PCT/PCT Application No.:** IT 2015/000015
(87) **N° publication PCT/PCT Publication No.:** 2015/125166
(30) **Priorité/Priority:** 2014/02/21 (IT TO2014A000145)

(51) **Cl.Int./Int.Cl.** ***C10B 53/07*** (2006.01), ***C10B 19/00*** (2006.01), ***C10B 27/00*** (2006.01), ***C10B 7/06*** (2006.01), ***C10G 1/02*** (2006.01), ***C10G 1/10*** (2006.01), ***C10L 3/00*** (2006.01)

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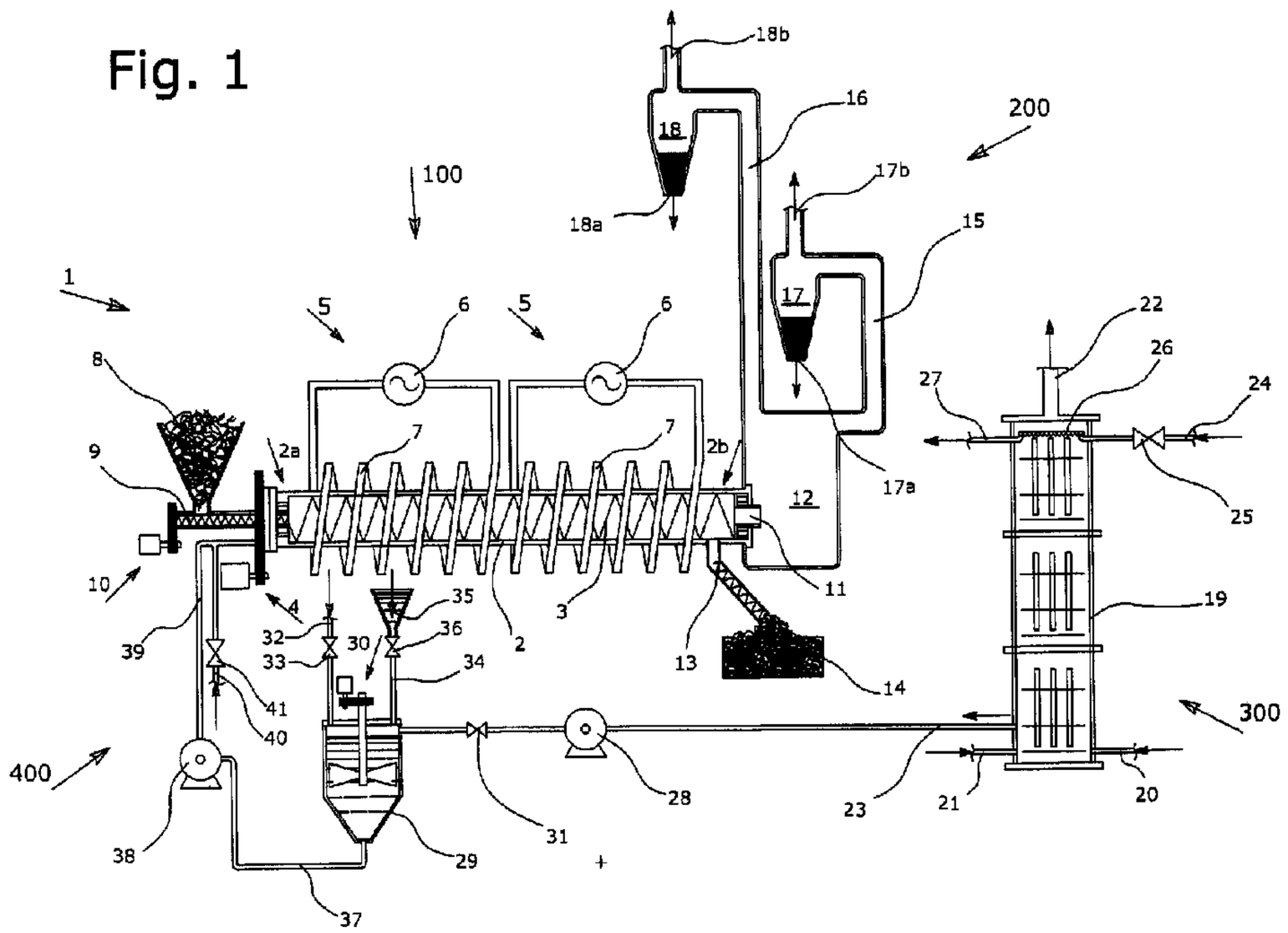
(54) **Titre : PROCEDE ET INSTALLATION POUR L'ELIMINATION DE DECHETS CONSTITUES DE MATIERES PLASTIQUES ET DE BIOMASSES**
(54) **Title: METHOD AND PLANT FOR DISPOSING OF WASTES COMPOSED OF PLASTIC MATERIALS AND BIOMASSES**

Fig. 1



(57) **Abrégé/Abstract:**
The present invention deals with a method and a plant for disposing of solid wastes, composed of plastic materials and biomasses, and liquid wastes, particularly composed of spend vegetal oils and greases. The method provides a pyrolysis treatment of the solid and liquid wastes, from which a synthesis gas (syngas) and an inert residual are obtained. The pyrolysis plant comprises: a first section (100), which performs the pyrolysis of solid and liquid waste materials, the pyrolysis producing synthesis gas (syngas) and residual ashes; a second section (200) which performs the separation of a lighter fraction of ashes (pulverized coal or carbon black) from syngas, the lighter fraction being transported by the syngas; a third section (300), which performs the fractioned distillation of syngas, obtaining the separation of the volatile fraction of syngas from a bituminous residual (tar); a fourth section (400), which performs the recycle of the bituminous residual of the fractioned distillation, for a further treatment.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 August 2015 (27.08.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/125166 A1

(51) International Patent Classification:
C10G 1/02 (2006.01) *C10B 53/07* (2006.01)
C10B 11/00 (2006.01) *C10G 1/10* (2006.01)
C10B 19/00 (2006.01)

(21) International Application Number:
PCT/IT2015/000015

(22) International Filing Date:
2 February 2015 (02.02.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
TO2014A000145 21 February 2014 (21.02.2014) IT

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

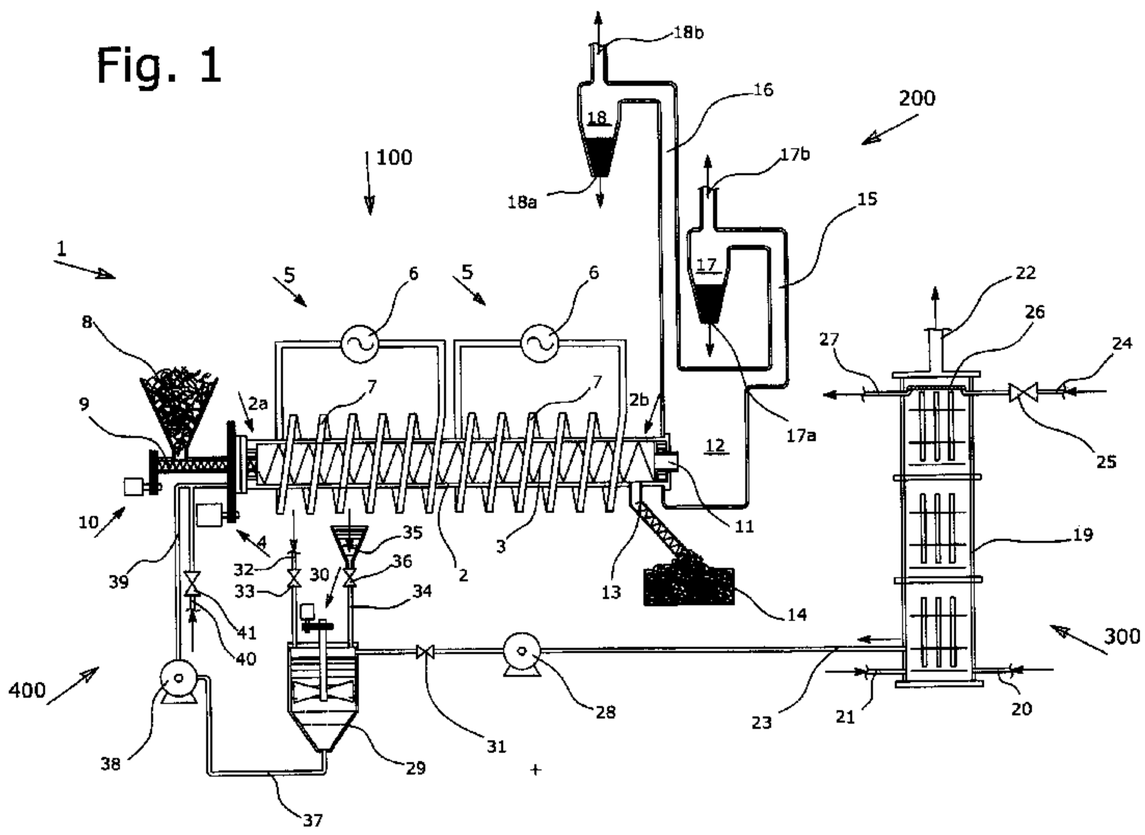
Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) Title: METHOD AND PLANT FOR DISPOSING OF WASTES COMPOSED OF PLASTIC MATERIALS AND BIO-MASSES

Fig. 1



(57) Abstract: The present invention deals with a method and a plant for disposing of solid wastes, composed of plastic materials and biomasses, and liquid wastes, particularly composed of spend vegetal oils and greases. The method provides a pyrolysis treatment of the solid and liquid wastes, from which a synthesis gas (syngas) and an inert residual are obtained. The pyrolysis plant comprises: a first section (100), which performs the pyrolysis of solid and liquid waste materials, the pyrolysis producing synthesis gas (syngas) and residual ashes; a second section (200) which performs the separation of a lighter fraction of ashes (pulverized coal or carbon black) from syngas, the lighter fraction being transported by the syngas; a third section (300), which performs the fractioned distillation of syngas, obtaining the separation of the volatile fraction of syngas from a bituminous residual (tar); a fourth section (400), which performs the recycle of the bituminous residual of the fractioned distillation, for a further treatment.

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METHOD AND PLANT FOR DISPOSING OF WASTES COMPOSED OF PLASTIC MATERIALS AND BIOMASSES

The present invention deals with a method and a plant for disposing of solid wastes, composed of plastic materials and biomasses, and liquid wastes, particularly composed of spend vegetal oils and greases.

Disposal of wastes is a big problem, since it is more and more difficult to find areas to be used as landfills, and burning to ashes has a high cost and, if not correctly performed, can give rise to environmental pollution.

Treatment plants have been devised, known as incinerators, which use plastic materials as fuel to produce heat, and also plants for treating the biomasses which, through fermenting, produce fuel gas.

The present invention proposes a new procedure for the disposal of plastic materials, of biomasses and of spent vegetal oils and greases, which allows obtaining fuel gas through a pyrolysis treatment.

The present invention therefore proposes a method, and a plant for performing said method, as claimed in the

respective independent claims

The method essentially consists in subjecting the solid and liquid wastes to be disposed of to a pyrolysis treatment, which allows extracting the synthesis fuel gas (syngas), obtaining an inert residual which gives no problems for its disposal in a landfill.

The plant substantially comprises:

- a first section in which pyrolysis of waste materials is performed, and synthesis gas (syngas) and residual ashes are produced;
- a second section in which the lighter fraction of such ashes, namely the pulverized coal or carbon black which is transported by the syngas, is separated from the syngas;
- a third section in which the fractioned distillation of the pyrolysis products occurs, obtaining high-boiling hydrocarbons, namely a bituminous residual (*tar*);
- a fourth section in which the recycle of the bituminous residual of the fractioned distillation occurs, for a further treatment, said bituminous residual being able to be mixed with the liquid wastes.

The pyrolysis chamber is substantially composed of a tube made of a special alloy, heated and equipped with a

mechanized system for the controlling handling and advancement of the solid mass to be subjected to the pyrolysis treatment. The tube is externally insulated with a ceramic fabric and, by means of a motor-reducer assembly, it is slowly turned around its own axis.

A feature of the plant is that it is energetically autonomous, since it uses part of the produced fuel gas to supply an endo-thermal motor which actuates an alternator, which provides the electric energy used for heating the pyrolysis chamber and for actuating all necessary devices for the operation of the plant.

The use of the method and of the plant of the invention definitely allows transforming solid and liquid wastes into a fuel gas and into inert residuals. Part of the fuel gas is used to produce the necessary energy for the operation of the whole plant, while the inert residual fraction, whose volume is much lower than the starting mass of the wastes, can be disposed of in a landfill without particular problems, both for the reduced amount of said ashes, and because they are not polluting.

The invention will now be described, as a non-limiting example, according to a preferred embodiment and with reference to the enclosed Figure 1, which shows the functional diagram of the pyrolysis plant.

With reference to Figure 1, (1) designates a pyrolysis plant, according to the invention, heated with high-frequency currents. The pyrolysis plant (1) comprises:

- a first section (100), in cui pyrolysis of waste materials is performed, synthesis gas (syngas) is produced and residual ashes of the treatment are discharged;
- a second section (200), in which the lighter fraction of the ashes (pulverized coal or carbon black) which is transported by the syngas, is separated from the syngas;
- a third section (300), in which the fractioned distillation of the pyrolysis products is performed, obtaining high-boiling hydrocarbons or bituminous residuals (*tar*);
- a fourth section (400), in which the recycle of the bituminous residual of the fractioned distillation is performed, for a further treatment.

The first section (100) comprises a cylinder (2), or pyrolysis chamber, rotating around its own axis, externally equipped with insulation, for example in ceramic fiber. Wings shaped as an Archimedean screw (3), with tempered surface through nitriding, are welded in the cylinder (2).

The cylinder (2) is rotated by a first motor-reducer assembly (4) and is internally heated by heating means (5), in order to take the solid mass to be pyrolyzed to a temperature of 680÷750°C.

According to a preferred embodiment, the internal diameter of the pyrolysis chamber (2) will preferably range between 650 and 950 mm, while the length will preferably range between 6000 mm and 8000 mm, with a rotation at a speed for example between 1 and 3 revolutions per minute. Moreover, said heating means (5) comprise two induction generators (6) at a radiofrequency variable between 1.5 kHz and 2.5 kHz and with a power from 80 to 120 kW each, each one of which is connected to a coil (7), inside which the pyrolysis cylinder (2) slowly rotates, The two coils transmit the high-frequency induced current created by the two generators, so that the cylinder (2) becomes seat of eddy currents which heat it due to Joule effect.

The temperature control is performed by means of two laser probes (not shown), placed at the inlet and at half the pyrolysis chamber (2). The two control points are composed, each, of three sequential detecting points.

Loading of the cylinder (2) occurs, at the first end (2a) of the cylinder (2), by means of a hopper (8) which supplies a scroll (9) rotated by a second motor-reducer

assembly (10).

The material is loaded at the inlet of the pyrolysis chamber (2). If the waste to be treated is solid, it is first minced in pieces whose size is about 1 cm and loaded by means of the scroll (9) with compression ratio preferably from 1:150 to 1:250 and with adjustable speed. If instead the waste is liquid, it is loaded in the recycling section (400), as better specified below.

The material loaded in the hopper (8) and inserted with pressure by the scroll (9), reaches inside the cylinder (2) whose rotation, coupled to the Archimedean screw (3), pushes it towards the second end (2b) of the cylinder (2).

In the path along the cylinder (2), at the + temperature of 680÷750°C, the solid waste, mainly composed of plastic materials like polyethylene, polypropylene, ABS, PET, polystyrene, polyurethanes, or of biomass (wood, depuration muds, rice straw, etc.) is subjected to pyrolysis, producing solid and gaseous compounds. The gaseous fraction, called syngas, comprises a mixture of H_2, CO, CO_2 CH_4 (volatile fraction at ambient temperature) and drags high-boiling hydrocarbons, oxygenated products having various molecular weights as steam and pulverized coal of carbon (carbon black), while the solid fraction comprises extremely reduced amounts of

residual ashes.

Through an opening (11), the syngas enters a settling chamber (12), while the residual ashes are discharged, through a duct (13), in a container (14).

The second section (200) comprises the settling chamber (12) from which the syngas is conveyed, through a first duct (15) and a second duct (16), towards a first cyclone (17) and, respectively, a second cyclone (18). Inside the cyclones (17) and (18), syngas is treated in order to complete the separation from the pulverized coal (carbon black) which it transported, the pulverized coal being discharged through a lower opening (17a, 18a) of said first and second cyclone (17, 18), while the syngas thereby depurated from the carbon black is exited from the upper part (17b, 18b).

The third section (300), in which the fractionated separation of the pyrolysis products occurs, comprises a column of fractioned distillation (19) composed of various overlapped elements equipped with condensation plates and cooling serpentines with adjustment of the necessary amount of water to keep each module ta the condensation temperature of the mixtures of high-boiling elements which thereby abandon the syngas. All condensed high-boiling elements are conveyed onto the column bottom.

In the lower part of the column of fractioned distillation (19) syngas coming from separating cyclones (17) and (18) enters through the ducts (20) and (21). In the column (19), the volatile fraction of syngas is separated from the high-boiling hydrocarbons, which compose said bituminous residual (*tar*) and exit from the upper outlet (22), while said high-boiling hydrocarbons go out of the lower outlet (23). Syngas is conveyed towards a blower (not shown) which creates a slight under-pressure in the pyrolysis chamber (2) and sends the syngas towards basic and acid washing columns (not shown).

Through a duct (24), which enters the top part of the column (19), cooling water is made pass, this inlet being controlled by a valve (25) and an electronic liter-counter (not shown). Water then crosses a serpentine (26) and exits, as overheated steam, from a duct (27).

In the fourth section (400), there is the recirculation of high-boiling hydrocarbons going out, through the duct (23), from the lower part of the fractioned distillation column (19), and of the coal powder (carbon black) extracted from the separating cyclones (17) and (18) placed at the outlet of the settling chamber (12).

The fourth section (400) comprises a pump (28) which

inserts said high-boiling hydrocarbons in a turbo-mixer (29), actuated by a third motor-reducer assembly (30), the flow of said high-boiling hydrocarbons being regulated by a valve (31).

Carbon black coming from cyclones (17) and (18) is inserted in the turbo-mixer (29) though a duct (32), the flow of said carbon black being regulated by a valve (33).

Through a duct (34), liquid wastes too (spent vegetal oils and greases) are inserted in the turbo-mixer (29), said liquid wastes being inserted in a hopper (35) and their flow being regulated by a valve (36).

In the turbo-mixer (29) an emulsion is produced which, going into a duct (37), reaches a pump (38) which inserts it into the pyrolysis chamber (2) through a duct (39). Through a duct (40), into the pyrolysis chamber (2) the overheated steam is inserted, which goes out of the fractioned distillation column (19) through the duct (27), the flow of steam being regulated by a valve (41).

The turbo-mixer (29) is able to thoroughly mix the carbon product going out of the separating cyclones and the extracted *tar* on the base of the fractioned distillation column (19). This mixing is re-inserted at the inlet of the pyrolysis chamber together with the overheated steam coming from the serpentines of the

fractioned separation column. The amount of steam is variable between 10% and 15% in weight of the waste loaded at the pyrolyzer inlet. This variation is due to the nature of the treated waste. This mixing becomes very efficient with the addition of spent vegetal oil, inserted in the hopper (35), coming from a differentiated collection, since it has excellent properties for dissolving the hydrocarbons, also at high concentrations.

The percentage of oxygen present in the pyrolysis chamber is controlled and recorded continuously by an analytical instrument of the SYN 100 type, capable of also verifying the percentage of CO, CO_2, H_2 and CH_4 in the produced syngas. To prevent both syngas from going out and oxygen from seeping in the pyrolysis chamber, the supply of the solid waste is performed with the scroll (9) with high compacting pressure and pre-heated at a suitable temperature (according to the type of waste) to allow the formation of a plug such as to guarantee the system seal to air, and therefore to oxygen, in the pyrolysis chamber (2). Between the loading hopper and the scroll, a star valve is inserted to avoid infiltrations of air, and therefore of oxygen obnoxious for the pyrolysis process.

The pyrolysis chamber (2) is kept at a slight under-pressure by the blower which sents the syngas towards the

basic and acid washing columns, the under-pressure being equal to about 0.7 mbar less than the external pressure.

In case of emergency, the produced syngas, after washing, is started as emergency torch, the induction generators are turned off and the pyrolysis chamber is washed with nitrogen gas.

The invention has been described as a non-limiting example, according to a preferred embodiment. The skilled people in the art could find numerous variations, all falling within the scope of the enclosed claims.

CLAIMS

1. Pyrolysis plant for treating solid and liquid wastes, comprising:

- a first section (100), adapted to perform a pyrolysis of said solid and liquid wastes, said pyrolysis producing synthesis gas (syngas) and residual ashes;
- a second section (200) adapted to perform the separation of a lighter fraction of said ashes (pulverized coal or carbon black) from said syngas, said lighter fraction being transported by the syngas;
- a third section (300), adapted to perform the fractioned distillation of said syngas, obtaining the separation of the volatile fraction of said syngas from a bituminous residual (*tar*);
- a fourth section (400), adapted to perform the recycle of the bituminous residual of said fractioned distillation, for a further treatment;

characterized in that said first section (100), adapted to perform said pyrolysis of said solid and liquid wastes, comprises a cylinder (2), or pyrolysis chamber, rotating around its own axis and equipped with:

- external insulation;
- means adapted to induce, by means of said rotation, an advancement of the material contained in said cylinder (2), said means comprising an Archimedean screw (3);
- means for loading the solid wastes placed at a first end (2a) of the pyrolysis cylinder (2);
- heating means (5), said heating means (5) comprising at least one radiofrequency induction generator (6), each one of said generators (6) being connected to a coil (7), inside which said pyrolysis cylinder (2) slowly rotates, said coil (7) transmitting the high-frequency induced current created by said at least one generator (6) so that the pyrolysis cylinder (2) becomes seat of eddy currents which heat it through Joule effect;
- means for rotating said cylinder (2).

2. Pyrolysis plant according to claim 1, characterized in that said insulation is made of ceramic fiber.

3. Pyrolysis plant according to claim 1, characterized in that said means for loading the solid wastes, placed at the first end (2a) of the pyrolysis cylinder (2), comprise a scroll (9), supplied by a hopper (8) and rotated by a second motor-reducer

assembly (10).

4. Pyrolysis plant according to claim 1, characterized in that said generators (6) produce currents having a frequency of 2.5 kHz and a power of 85 kW.

5. Pyrolysis plant according to claim 1, characterized in that said means for rotating said cylinder (2) comprise a first motor-reducer assembly (4).

6. Pyrolysis plant according to claim 1, characterized in that said means for loading the solid wastes comprise a hopper (8) which supplies a scroll (9) rotated by a second motor-reducer assembly (10).

7. Pyrolysis plant according to claim 6, characterized in that said scroll (9) supplies said solid waste with a compression ratio of about 1:200 and is pre-heated at a suitable temperature (according to the type of waste) to allow forming a plug adapted to prevent both syngas from going out, and oxygen from going in the pyrolysis chamber (2).

8. Pyrolysis plant according to claim 1, characterized in that said second section (200), adapted to perform the separation of the lighter fraction of said ashes (pulverized coal or carbon black) from said syngas, comprises a settling chamber (12) which collects the syngas going out of said pyrolysis chamber (2), at least one duct (15, 16) being

provided, adapted to convey said syngas towards at least one cyclone (17, 18) inside which the syngas is treated in order to perform the separation from the pulverized coal (carbon black) transported by said syngas, said pulverized coal being discharged through a lower opening (17a, 18a) of said at least one cyclone (17, 18), while the thereby cleaned syngas is made go out from the upper part (17b, 18b).

9. Pyrolysis plant according to claim 1, characterized in that said third section (300), adapted to perform the fractioned distillation of said syngas, comprises a column (19), in which there are:

- ducts (20) and (21), placed in the lower part of said column (19), through which enters the syngas coming from said separating cyclones (17) and (18);
- an outlet (22), placed in the top part of said column (19), from which the syngas goes out after the separation from the bituminous residual (*tar*), said syngas being conveyed towards a blower adapted to create a slight under-pressure in the pyrolysis chamber and to send the syngas towards the washing columns;
- an outlet (23), placed in the lower part of said

column (19), from which said bituminous residual goes out.

10. Pyrolysis plant according to claim 9, characterized in that said fractioned distillation column (19) further comprises a duct (24), which enters in the top part of said column (19), in which cooling water is passed, said water crossing a serpentine (26) and going out, as overheated steam, from a duct (27).

11. Pyrolysis plant according to claim 1, characterized in that said fourth section (400), adapted to perform the recycle of the bituminous residual of said fractioned distillation, comprises:

- a turbo-mixer (29), actuated by a third motor-reducer assembly (30), in cui sàid bituminous residual is inserted;
- a duct (32), through which the carbon black coming from the cyclones (17) and (18) is inserted in the turbo-mixer (29);
- a duct (34), through which liquid wastes (spent vegetal oils and greases) are inserted in the turbo-mixer (29);

in the turbo-mixer (29) an emulsion being produced, which is inserted in the pyrolysis chamber (2).

12. Pyrolysis plant according to claim 11, characterized in that said fourth section (400),

adapted to perform the recycle of the bituminous residual of said fractioned distillation, further comprises a duct (40) through which the overheated steam coming from the fractioned distillation column (19) is inserted in the pyrolysis chamber (2), through said duct (27).

13. Method for treating solid and liquid wastes, characterized in that it is performed through a plant according to any one of the previous claims, said method providing a pyrolysis treatment of said solid and liquid wastes, from which a synthesis gas, syngas, and an inert residual are obtained, said method comprising the steps of subjected to fractioned distillation the pyrolysis products, and sending to a new pyrolysis cycle the bituminous residuals (*tar*) of said fractioned distillation, said solid wastes comprising plastic materials and biomasses and being loaded directly into the pyrolysis chamber (2) in which they are subjected to said pyrolysis treatment, said liquid wastes comprising spent oils and greases which are inserted in said pyrolysis chamber (2) after mixing with said bituminous residuals (tar) coming from the fractioned distillation of the pyrolysis products.

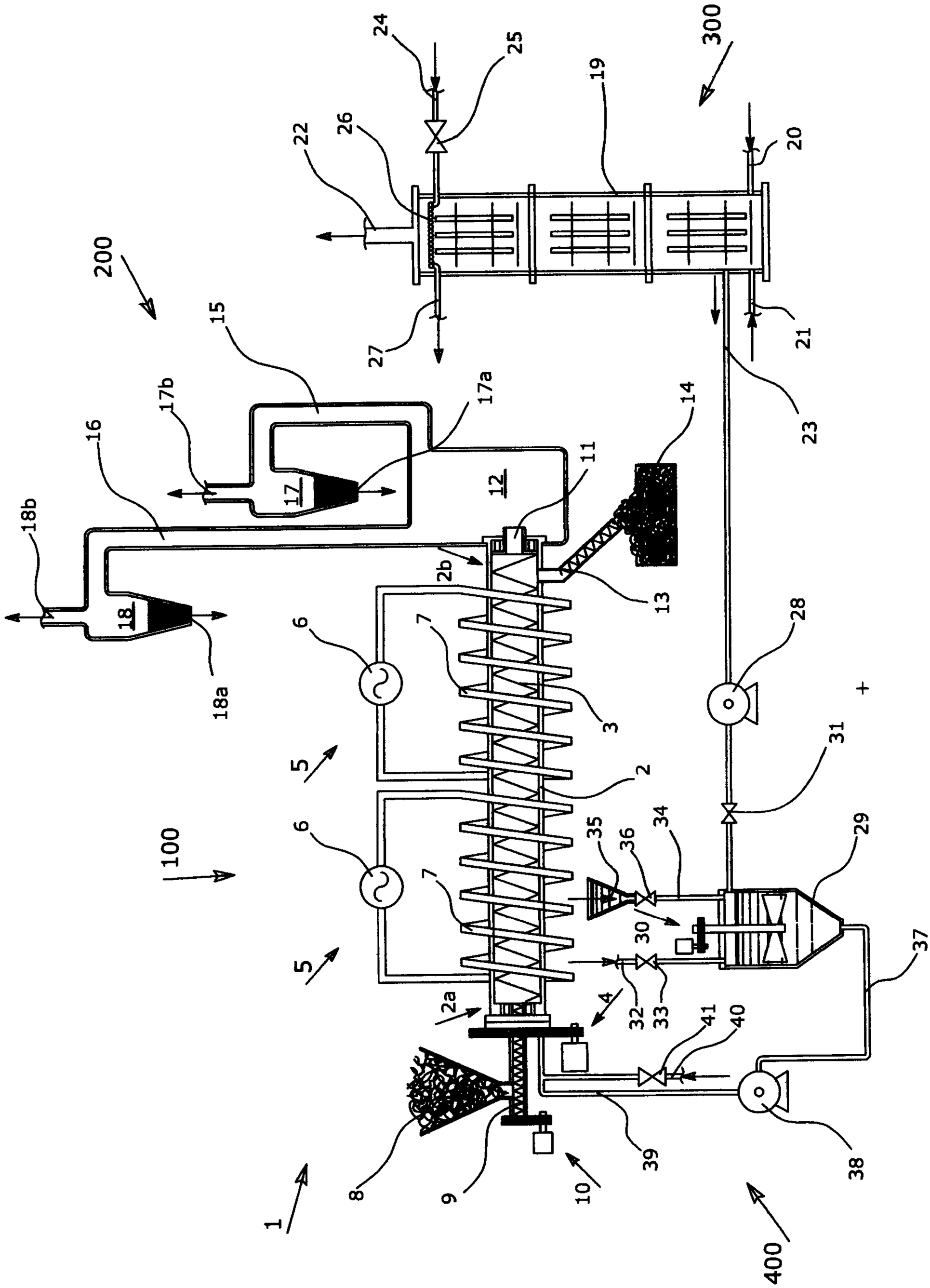
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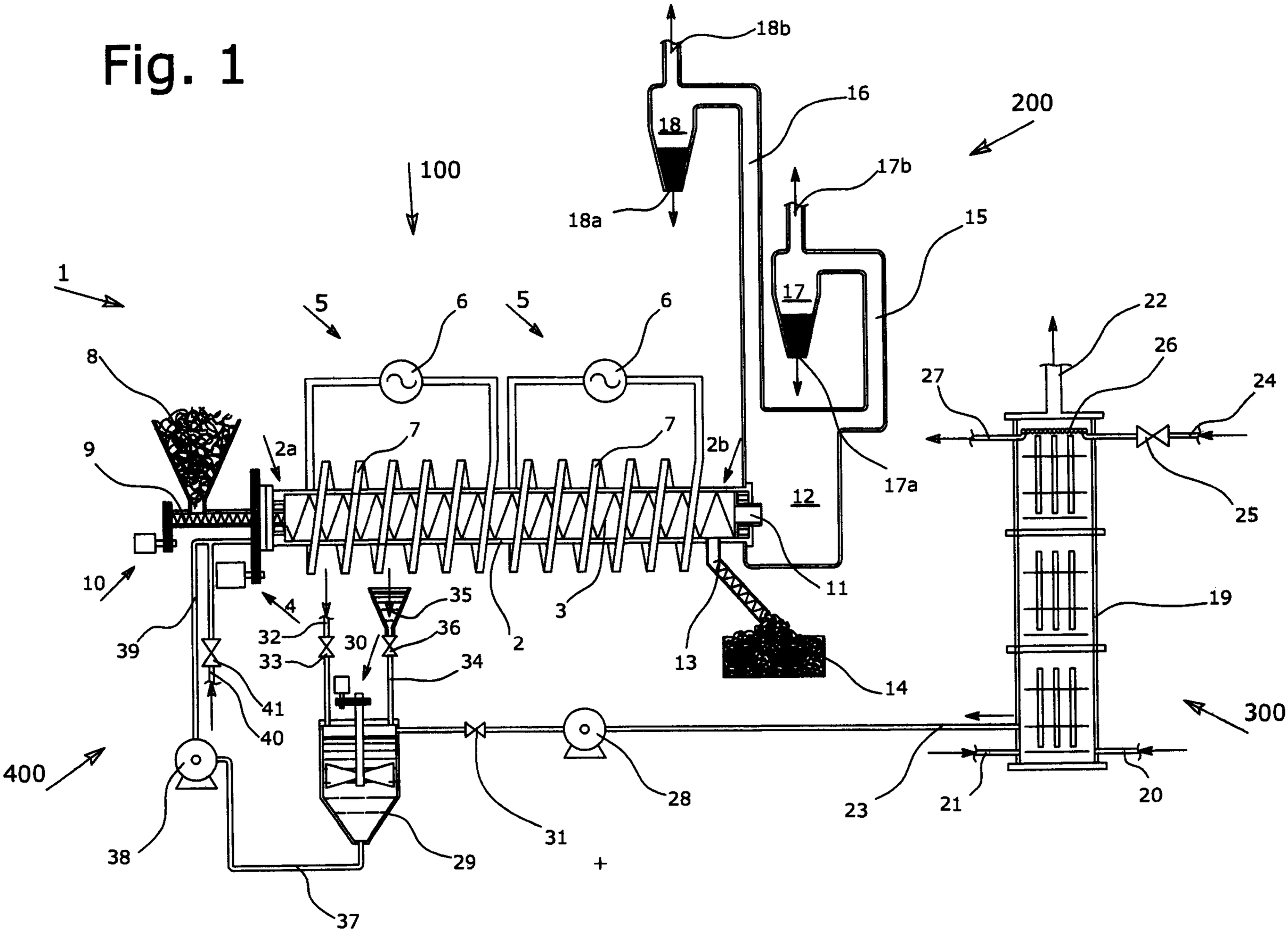
Fig. 1

Fig. 1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