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(57) Abstract: According to the present invention, the important characteristic of the construction of the jet gasifier (drawing no. 1) consists in that it includes, among others, a dry steam generator (SG) supplied from the outside, a steam superheater (SS), an injector jet pump (IJP), a system for feeding the fragmented mass to be gasified (MFS), preferably biomass, a reaction chamber (RC), an ejector jet pump (EJP), a water pump (WP), a separation and cooling system (SCS), a combustible gas container (CGC), valves, to include safety valves, various meters and sensors, in particular temperature and pressure meters and sensors, and a control system, and that these components are connected in such a way that the steam outlet from the dry steam generator (SG) is hydraulically connected, preferably through electrically controlled pressure reducing valve (PRV₁), with the inlet of the steam superheater (SS), and its outlet is connected with the supply nozzle (nozzle propeller) of the injector jet pump (IJP), and its inlet port is hydraulically connected with the fragmented mass outlet in its feeding system (MFS), while the outlet port of the injector jet pump (IJP) is hydraulically connected, preferably with a flange packing (P), with the inlet of the reaction chamber (RC), which can have the shape, preferably, of a spiral coil, in particular of a vertical cylinder, as shown on drawings no. 1-3, whose upper opening constitutes the chamber's inlet and the lower opening - its outlet, and the outlet of the chamber (RC) is hydraulically connected, preferably with a flange packing (P), with the inlet port of the ejector jet pump (EJP), and the supply nozzle (nozzle propeller) of the ejector jet pump (EJP) is hydraulically connected, preferably by an electrically controlled pressure reducing valve (PRV₂), with the outlet of the water pump (WP), while the outlet port of the ejector jet pump is hydraulically connected with the inlet of the separation and cooling system (SCS), and the outlet of the purified and cooled mix of combustible gases from the system (SCS) is connected through a check valve (CV) with the combustible gas container (CGC), while the outlet of purified and cooled water from the system (SCS) is hydraulically connected with the inlet of the water pump (WP), and the electronically controlled valves located in the aforementioned components and the electronic meters and sensors, in particular pressure and temperature meters and sensors, are electrically connected with the control system, and, moreover, the hydraulic connections between the individual components of the gasifier and the reaction chamber (RC) and the housings of the jet pumps (IJP and EJP) are lined with a layer of thermal insulation, and the components that are exposed to high temperatures are made from high-temperature creep resistant materials, preferably from superalloys. (6 claims)

JET GASIFIER AND ITS CONTROL METHOD

The present invention relates to a jet gasifier which is in particular designed for gasifying fragmented solid substances of proper chemical composition, e.g. coal or, in particular, biomass.

Gasification consists of two principal processes: the process of pyrolysis (degassing), which results in the solid substance to be gasified being transformed into pyrolytic gases and carbonization product, and the process of actual gasification where the coal in the carbonization product reacts with a volatile gasification agent, usually atmospheric oxygen or steam, which in the case of the former agent results in the production of carbon dioxide and in the case of the latter agent – carbon monoxide and hydrogen and in some conditions methane (when the pressure of the process is high), and where solid mineral components are produced from the carbonization product. The process of gasification of a selected solid requires heat because the thermal balance of both pyrolysis and actual gasification indicate the prevalence of endothermic processes. Although, it should be noted that some of the reactions taking place as a part of these processes are exothermic.

There are numerous types of gasifiers. Three of them are described below. The first type, which is the most traditional and is used for gasification of wood, is one where the reaction chamber, where pyrolysis and then the actual gasification take place, and the biomass combustion chamber form one integral component. In such gasifiers, the heat required for the process is generated during the partial burning of the wood being gasified. The construction of such gasifiers is similar to that of regular grate furnaces, with the exception that air and possibly steam (when steam is the gasifying agent) is supplied to their enlarged combustion chamber through specially located connection ports. Such gasifiers also have proper outlet connection ports to remove the gas mix produced inside. Wood is put into such gasifiers from the top, often through a lock, so as to better control the quantity of air supplied into the reaction chamber. As wood moves gravitationally down the reaction chamber, it becomes hotter, it degasses and becomes partly gasified. A part of the wood, mostly in the form of carbonization product, falls down and reaches the actual combustion chamber and burns on a grate, thus providing heat for the wood in the upper parts of the gasifier. The process can be controlled through regulation of the quantity of air and gasification agent supplied through the aforementioned connection ports. The combustible gas that is collected from the gasifier is very polluted and must be treated in a filtration and separation system. Moreover, the burned wood is transformed into ash which is collected underneath the grate.

The second type of gasifiers that currently used is one where the reaction chamber is closed and heat is supplied to the chamber using the membrane method, i.e. by heating up its walls, e.g. with gas burners supplied with some of the combustible gas produced in the gasification process.

The third type of gasifiers, invented fairly recently, is gasifiers for gasification of various substances which use a liquid metal reactor (LMR). The reactor consists of a ceramic container with melted metal inside. The temperature of the metal is maintained by induction currents or by gas burners. In such gasifiers, the reaction chamber is the space between the surface of the melted metal and the dome (usually ceramic) that covers the top of the container. The material to be gasified is fed into the reaction chamber from the top through a charging lock in the dome. Steam or sprayed water is fed into the chamber through a proper connection port. Another connection port is used for removing the gas mix produced in the chamber. The solid mineral components produced in the gasification process float on the surface of the melted metal and are removed from the container from time to time through a tapping point.

Some assumptions have been made in the description which follows and in drawings no. 1 – 3 which the description refers to. These assumptions must be taken into consideration in order to properly assess the information contained therein. The description is not a strictly technical description, which means that it does not include such information as the location of pressure and temperature meters and sensors and the location of some valves, e.g. safety valves, which conforms to general engineering principles. Also, drawings no. 1-3 and the description do not mention valves that are typically an integral part of components used in the gasifier, e.g. a steam generator or a water pump. The description does not include the structure of the separation and cooling system because there are numerous technical solutions available in the market which allow for separation of solid particles from water, separation of insoluble gases (carbon monoxide, hydrogen, and methane are, in principle, such gases), and separation of soluble gases, i.e. carbon dioxide, or, possibly, chemical removal of other pollutants from water.

Moreover, when analyzing drawings no. 1-3, one must assume that the proportions of dimensions of elements shown therein are not technically significant, but are of qualitative importance only. The drawings do not show a control system which is electrically connected with each of the components as this would make the drawing too intricate and would not add any more value to the information concerning the control system that can be found in the description. For the same reason, the drawings do not show the thermal and electric insulation

of the spiral steam superheater (SS) as well as the insulation of other components, i.e. both jet pumps, the reaction chamber, and the hydraulic connections between the individual components of the gasifier. Also, the solid substance to be gasified is simply called "mass."

According to the present invention, the significant characteristic of the construction of the jet gasifier **consists in** that it includes (drawing no. 1) among others a dry steam generator (SG) supplied from the outside, a steam superheater (SS), an injector jet pump (IJP), a system for feeding the fragmented mass to be gasified (MFS), preferably biomass, a reaction chamber (RC), an ejector jet pump (EJP), a water pump (WP), a separation and cooling system (SCS), a combustible gas container (CGC), valves, to include safety valves, various meters and sensors, in particular temperature and pressure meters and sensors, and a control system, and that these components are connected in such a way that the steam outlet from the dry steam generator (SG) is hydraulically connected, preferably through electrically controlled pressure reducing valve (PRV₁), with the inlet of the steam superheater (SS), and its outlet is connected with the supply nozzle (nozzle propeller) of the injector jet pump (IJP), and its inlet port is hydraulically connected with the fragmented mass outlet in its feeding system (MFS), while the outlet port of the injector jet pump (IJP) is hydraulically connected, preferably with a flange packing (P), with the inlet of the reaction chamber (RC), which can have the shape, preferably, of a spiral coil, in particular of a vertical cylinder, as shown on drawings no. 1-3, whose upper opening constitutes the chamber's inlet and the lower opening – its outlet, and the outlet of the chamber (RC) is hydraulically connected, preferably with a flange packing (P), with the inlet port of the ejector jet pump (EJP), and the supply nozzle (nozzle propeller) of the ejector jet pump (EJP) is hydraulically connected, preferably by an electrically controlled pressure reducing valve (PRV₂), with the outlet of the water pump (WP), while the outlet port of the ejector jet pump is hydraulically connected with the inlet of the separation and cooling system (SCS), and the outlet of the purified and cooled mix of combustible gases from the system (SCS) is connected through a check valve (CV) with the combustible gas container (CGC), while the outlet of purified and cooled water from the system (SCS) is hydraulically connected with the inlet of the water pump (WP), and the electronically controlled valves located in the aforementioned components and the electronic meters and sensors, in particular pressure and temperature meters and sensors, are electrically connected with the control system, and, moreover, the hydraulic connections between the individual components of the gasifier and the reaction chamber (RC) and the housings of the jet pumps (IJP and EJP) are lined with a layer of thermal insulation, and the components that are

exposed to high temperatures are made from high-temperature creep resistant materials, preferably from superalloys.

Another important characteristic of the construction of the jet gasifier **consists in** that its steam superheater (SS) (drawing no. 2) consists of a heater (H) which is a pipe, preferably spiral-shaped, made from a high-temperature creep resistant material that conducts electricity, preferably a superalloy, and one end opening of the pipe is hydraulically connected with the steam outlet of the dry steam generator (SG) while the other is hydraulically connected with the supply nozzle (nozzle propeller) of the injector jet pump (IJP), and these connections, preferably flange-type, consist of a sealing and insulating part (SI) which insulates both connected components electrically; moreover, an electric current source (ECS) is connected to the end parts of the aforementioned pipe and is controlled by the control system of the gasifier and the whole heater pipe is thermally and electrically insulated on the outside, and, moreover, the pipe has temperature and pressure meters and safety valves which are also electrically connected to the control system, while a properly selected superalloy, of which the heater (H) pipe is made, allows for heating up the steam coming from the generator (SG) and flowing through the steam superheater (SS) to a temperature $t_{pp} > 1000\text{ }^{\circ}\text{C}$.

Another important characteristic of the construction of the jet gasifier **consists in** that the heater (H) pipe in the steam superheater (SS) is divided into several electrically-insulated sections, of which each is supplied with electric power separately, in particular with currents of different intensity.

Another important characteristic of the construction of the jet gasifier **consists in** that the heater (H) pipe in the steam superheater (SS) has different wall thicknesses in different sections which leads to different quantities of heat being emitted in the different sections.

Another important characteristic of the construction of the jet gasifier **consists in** that its feeding system (MFS), i.e. the system for feeding the fragmented mass to be gasified, consists of a funnel-shaped fragmented mass container (MC) (drawing no. 3), preferably with a vibrator, and the bottom round-shaped opening of the funnel is located exactly above the inlet of the chamber of a screw driven by an electric motor (EM) and is hydraulically connected with this inlet, while the outlet of the screw chamber is located exactly above the inlet port of the injector jet pipe (IJP) and is hydraulically connected with the port through an electrically-controlled stop valve (SV), and the rotating screw collects, through the open valve (SV), the fragmented mass from the container (MC) and moves it towards the suction port of the injector jet pipe (IJP) through which it is sucked in by a steam jet from the supply nozzle (nozzle propeller) of the injector jet pipe (IJP), whereas the operation of the valve (SV) and

the operation and rotation of the motor (EM) are controlled by the control system of the gasifier.

According to the present invention, the important characteristic of the control method of the jet gasifier **consists in** that the dry steam generator (SG) produces from externally-supplied water a jet of dry steam with the temperature t_{SG} and pressure p_{SG} and that the jet is directed, preferably through a pressure reducing valve (PRV_1), to the steam superheater (SS) where the steam is heated up to a set high temperature t_{pp} , and from the superheater (SS), the steam jet is directed to the supply valve (valve propeller) of the injector jet pump (IJP) where the speed of the jet is increased and its pressure is decreased below the pressure level in the mass feeding system (MFS), which is generally below 1 bar, which allows for sucking the fragmented mass with the jet through the inlet port of the injection jet pump from the mass feeding system (MFS) and then for directing the steam jet mixed with the sucked-in mass to the injector jet pipe (IJP) diffuser where the speed of the jet is decreased and its pressure is increased (but not to exceed the original value of p_{WP}), and from the diffuser the steam jet mixed with the sucked-in fragmented mass is directed, through the outlet port of the injector jet pump (IJP), to the reaction chamber (RC) while simultaneously starting to rapidly heat up the fragmented mass by absorbing the heat of the surrounding steam, which leads to a drop of the temperature of the steam and an increase of the temperature of the fragmented mass and, as the steam jet with the fragmented mass moves through the chamber (RC), the pyrolysis process (degassing of the fragmented mass) starts and quickly reaches the temperature of an exothermic phase from which moment the mass particles heat themselves up and the process is continued at an increasingly high temperature, and the actual gasification process begins, which consists in a reaction between the coal included in the carbonization product, i.e. the solid product of pyrolysis of the fragmented mass, and the steam, which produces mostly carbon monoxide and hydrogen, and the carbonization product is transformed into mineral substances, and as a result of these processes, at the outlet of the chamber (RC), which is hydraulically connected with the inlet port of the ejector jet pump (EJP), a mix of hot gases is produced, which include residual amounts of steam and solid mineral substances and the supply (drive) agent of the ejector jet pump (EJP) is cool water, and the jet of this water is guided to the supply nozzle (nozzle propeller) of the ejector jet pump (EJP) from the pump (WP), preferably through a pressure reducing valve (PRV_2), at pressure p_{WP} , which is higher than the pressure in the reaction chamber (RC) and in the supply nozzle of the ejector jet pump, the speed of the jet of this water is increased and its pressure is lowered below the level of pressure in the chamber

(RC), which allows for sucking in, through the inlet port of the ejector jet pipe (EJP), from the chamber outlet, the mix of gases and solid mineral substances, and after the mix is sucked in by the jet of water, the jet is directed to the diffuser of the ejector jet pump (EJP), where its speed is reduced and its pressure is increased (but not to exceed the original p_{PW} value), and from the diffuser the jet of water, which already contains the cooled gases and mineral substances, is directed to the separation and cooling system (SCS) where, according to known methods, a mix of combustible gases and small quantities of atmospheric gases, mostly nitrogen, are recovered, which are sucked in by the injector jet pump (IJP) together with fragmented mass from the mass feeding system (MSF), and a mix of these gases is purified and directed, through a check valve (CV), to the container (CGC); moreover, in the separation and cooling system (SCS), according to known methods, non-soluble solid mineral substances and carbon dioxide are separated from the water, and the water is cooled and treated to be reused and, if necessary, chemical, non-soluble pollutants are precipitated from the water, and then the water is directed from the separation and cooling system (SCS) to the water pump (WP) and more water is added as required.

The advantages of the jet gasifier

In the jet gasifier:

- selecting proper extent of fragmentation of the mass to be gasified results in the mass having large heat transfer surface;
- sucking-in of the fragmented mass with superheated steam with temperature as high as 1,100 °C results in the mass being heated up instantaneously with the heat of the steam (the temperature of the steam drops by several hundred degrees Celsius) and in a speedy pyrolysis;
- the speedy heating-up of the fragmented mass that is sucked in by the superheated steam leads to the mass reaching, in an equally speedy manner, the temperature of initiation of exothermic pyrolysis processes which not only sustain the process temperature, but even increase it; thanks to this the gasification process can take place at a temperature exceeding 750 °C, which eliminates ring hydrocarbons and guarantees high degree of gasification;

- the speedy sucking-in by the cool water of the hot mix of products of gasification leads to the products being cooled quickly, which limits the possibility of recombination of complex hydrocarbon compounds;
- the mix of combustible gases obtained as a result of gasification is characterized by relatively high heat of combustion because it is almost free from ballast gases such as nitrogen and carbon dioxide;
- the method of feeding the mass to be gasified and collecting the products of gasification allows for both uniform operation of the device and for leaktightness of the volume where the processes of pyrolysis and gasification take place.

Example of an application

An example of application for a jet gasifier is a gasifier for gasification of straw. The construction of the gasifier is shown on drawings no. 2 and 3, i.e. it consists of a steam superheater (SS) shown on drawing no. 2 and a straw feeding system (MFS) shown on drawing no. 2. The dry steam generator (SG) is a standard dry steam generator where the heat needed for evaporation of water comes from combustion of wood or biomass briquettes. The generator produces slightly superheated dry steam with temperature $t_{WP} > 100\text{ }^{\circ}\text{C}$, but not exceeding $200\text{ }^{\circ}\text{C}$, and pressure in the range of several bars. The spiral heater (H) pipe of the superheater (SS) is made from a high-temperature creep resistant INCONEL superalloy which is suitable for use in temperatures up to $1200\text{ }^{\circ}\text{C}$. The ends of the pipe are connected to a low-voltage power source. The current flows through the pipe which heats up the steam flowing through it to the temperature t_{PP} in the range of $900\text{--}1000\text{ }^{\circ}\text{C}$. As indicated in the description, the spiral-shaped heater of the superheater is thermally and electrically insulated on the outside. Moreover, the sealing and insulating elements (SI) in flange connections insulate the heater (H) electrically from the steam generator (SG) and the injector jet pump (IJP). The jet of superheated steam coming from the superheater (SS) moves to the supply nozzle of the injector jet pump where the pressure of the steam is lowered below one bar and the flow rate of the steam increases. This allows for the steam jet to suck in, through the inlet port of the injector jet pump, the fragmented straw fed to the inlet port through the straw feeding system (MFS). The injector jet pump (IJP) is also made from INCONEL superalloy. The straw

feeding system (MFS) consists of a charging hopper closed on the top into which fragmented straw is fed from the top by a screw conveyor. The charging hopper is equipped with a vibrator which causes the straw to move down in a uniform fashion towards a round narrow outlet leading to the screw chamber. It should be noted that the finer the fragmented straw is, the less air is in the bottom part of the charging hopper and the less air is fed with the straw to the inlet port of the injector jet pump (IJP). The screw located in the chamber connected to the round outlet of the charging hopper is driven by an electric motor (EM) whose operation and rotational speed is controlled by the control system of the gasifier. By changing the rotational speed of the screw, one can increase or decrease the amount of straw fed into the injector jet pump (IJP). Between the inlet port of the injector jet pump (IJP) and the outlet of the screw chamber in the straw feeding system (UPM) there is an electrically-controlled stop valve (SV) which is closed when the operation of the gasifier is completed or when, for some reason, the level of straw in the charging hopper drops below a permitted level. This eliminates the possibility of the injector jet pump (IJP) sucking in air only. The fragmented straw that is sucked in by the inlet port of the injector jet pump (IJP) is mixed in the pump with a jet of hot steam and it starts to heat up and travels, along with the steam jet, to the diffuser of the injector jet pump where the pressure of the steam jet increases above one bar, but not in excess of the original level. From the diffuser, the steam jet mixed with straw particles flows to the reaction chamber (RC). The shape of the chamber resembles that of the spiral heater (H) in the superheater (SS) and the chamber is made from the same superalloy as the heater and is also thermally insulated on the outside. The length of the chamber (RC) depends on the estimated time of the processes of pyrolysis and gasification, at the assumed size of the steam jet and the amount of straw fed to the chamber. This is why a spiral shape of the reaction chamber (RC) is better than a vertical cylindrical shape, as the former allows it to be significantly longer. In the front part of the reaction chamber, the temperature of steam drops while the temperature of straw particles increases as straw heats up by absorbing the energy of the surrounding steam, but in the further part of the chamber this process is reversed. After the straw particles reach a temperature between 300 and 500 °C, the pyrolysis processes in them go into the exothermic phase, which means that heat is emitted, which raises the temperature of the partly degassed particles and heats up the gases surrounding the particles. As a result, the temperature of the process in the further part of the reaction chamber rises and proper gasification can take place in a temperature exceeding 750 °C, which eliminates ring hydrocarbons and guarantees high efficiency of the gasification process. Generally speaking, proper gasification consists in effecting a reaction of the product of carbonization of straw in

the process of pyrolysis, or degassing, with steam. The carbonization product consists mostly of coal and small amounts of mineral compounds. The coal combines with steam to produce carbon monoxide and hydrogen. Thus, straw is gasified to produce small amounts of solid mineral substances. The mix of gasification products, which, besides gases, contains the aforementioned mineral substances, is sucked in from the outlet of the reaction chamber (RC) by the inlet port of the ejector jet pump (EJP). The supply (driving) agent of the ejector jet pump (EJP) is water, which is fed into its supply nozzle by the pump (WP) at the pressure of at least several bars. On the way from the pump to the nozzle of the ejector jet pump, the water passes through a pressure reducing valve (PRV₂) which serves the purpose of regulating the pressure of the water. In the supply nozzle, the pressure of the water drops below the level in the reaction chamber, while the speed of the water jet increases. This allows the water jet in the ejector jet pump to suck in the products of gasification of straw from the outlet of the reaction chamber with an inlet port. After the gasification products mix with water, they are cooled instantaneously, which limits the possibility for recombination of ring hydrocarbons. The jet of water mixed with the sucked-in gasification products travels to the diffuser of the ejector jet pump (EJP) where the pressure of the mix increases slightly; then the mix moves through the outlet port of the ejector jet pump (EJP) to the separation and cooling system. The separation and cooling system (SCS) recovers, according to a known method, a mix of combustible gases and small quantities of air gases, mostly nitrogen, which have been sucked in by the injector jet pump (IJP) together with fragmented straw from the straw feeding system (MFS). The mix is purified and directed to the container (CGC) through a check valve (CV). Moreover, the separation and cooling system (SCS) separates, using a known method, non-soluble particles of mineral compounds and carbon dioxide from the water, and cools and treats the water to be reused. The treated water is directed to the inlet of the pump (WP). The water that drives the ejector jet pump basically circulates in a closed loop, but a quantity of it always leaves the loop, e.g. during the removal of solid mineral substances from the separation and cooling system (SCS). One must remember that a quantity of the superheated steam, which must always be supplied in a slightly excessive amount so as to make gasification possible, does not react with coal in the chamber (RC) and, after being sucked in and cooled, condenses in the ejector jet pump (EJP). Nevertheless, the water in the ejector jet pump loop (EJP) must be exchanged every so often and this is why the loop should have proper valves allowing for this operation.

PATENT CLAIMS

1. 1. A jet gasifier, **characterized in** that it includes (drawing no. 1) among others a dry steam generator (SG) supplied from the outside, a steam superheater (SS), an injector jet pump (IJP), a system for feeding the fragmented mass to be gasified (MFS), preferably biomass, a reaction chamber (RC), an ejector jet pump (EJP), a water pump (WP), a separation and cooling system (SCS), a combustible gas container (CGC), valves, to include safety valves, various meters and sensors, in particular temperature and pressure meters and sensors, and a control system, and that these components are connected in such a way that the steam outlet from the dry steam generator (SG) is hydraulically connected, preferably through electrically controlled pressure reducing valve (PRV₁), with the inlet of the steam superheater (SS), and its outlet is connected with the supply nozzle (nozzle propeller) of the injector jet pump (IJP), and its inlet port is hydraulically connected with the fragmented mass outlet in its feeding system (MFS), while the outlet port of the injector jet pump (IJP) is hydraulically connected, preferably with a flange packing (P), with the inlet of the reaction chamber (RC), which can have the shape, preferably, of a spiral coil, in particular of a vertical cylinder, as shown on drawings no. 1-3, whose upper opening constitutes the chamber's inlet and the lower opening – its outlet, and the outlet of the chamber (RC) is hydraulically connected, preferably with a flange packing (P), with the inlet port of the ejector jet pump (EJP), and the supply nozzle (nozzle propeller) of the ejector jet pump (EJP) is hydraulically connected, preferably by an electrically controlled pressure reducing valve (PRV₂), with the outlet of the water pump (WP), while the outlet port of the ejector jet pump is hydraulically connected with the inlet of the separation and cooling system (SCS), and the outlet of the purified and cooled mix of combustible gases from the system (SCS) is connected through a check valve (CV) with the combustible gas container (CGC), while the outlet of purified and cooled water from the system (SCS) is hydraulically connected with the inlet of the water pump (WP), and the electronically controlled valves located in the aforementioned components and the electronic meters and sensors, in particular pressure and temperature meters and sensors, are electrically connected with the control system, and, moreover, the hydraulic connections between the individual components of the gasifier and the reaction chamber (RC) and the housings of the jet pumps (IJP and EJP) are lined with a layer of thermal insulation, and the components that are exposed to high temperatures are made from high-temperature creep resistant materials, preferably from superalloys.

2. The jet gasifier, according to claim no. 1, **characterized in** that its steam superheater (SS) (drawing no. 2) consists of a heater (H) which is a pipe, preferably spiral-shaped, made from a high-temperature creep resistant material that conducts electricity, preferably a superalloy, and one end opening of the pipe is hydraulically connected with the steam outlet of the dry steam generator (SG) while the other is hydraulically connected with the supply nozzle (nozzle propeller) of the injector jet pump (IJP), and these connections, preferably flange-type, consist of a sealing and insulating part (SI) which insulates both connected components electrically; moreover, an electric current source (ECS) is connected to the end parts of the aforementioned pipe and is controlled by the control system of the gasifier and the whole heater pipe is thermally and electrically insulated on the outside, and, moreover, the pipe has temperature and pressure meters and safety valves which are also electrically connected to the control system, while a properly selected superalloy, of which the heater (H) pipe is made, allows for heating up the steam coming from the generator (SG) and flowing through the steam superheater (SS) to a temperature $t_{pp} > 1000\text{ }^{\circ}\text{C}$.

3. The jet gasifier, according to claim no. 2, **characterized in** that the heater (H) pipe in the steam superheater (SS) is divided into several electrically-insulated sections, of which each is supplied with electric power separately, in particular with currents of different intensity.

4. The jet gasifier, according to claim no. 2, **characterized in** that the heater (H) pipe in the steam superheater (SS) has different wall thicknesses in different sections which leads to different quantities of heat being emitted in the different sections.

5. The jet gasifier, according to claim no. 1 or 2 or 3 or 4, **characterized in** that its feeding system (MFS), i.e. the system for feeding the fragmented mass to be gasified, consists of a funnel-shaped fragmented mass container (MC) (drawing no. 3), preferably with a vibrator, and the bottom round-shaped opening of the funnel is located exactly above the inlet of the chamber of a screw driven by an electric motor (EM) and is hydraulically connected with this inlet, while the outlet of the screw chamber is located exactly above the inlet port of the injector jet pipe (IJP) and is hydraulically connected with the port through an electrically-controlled stop valve (SV), and the rotating screw collects, through the open valve (SV), the fragmented mass from the container (MC) and moves it towards the suction port of the injector jet pipe (IJP) through which it is sucked in by a steam jet from the supply nozzle (nozzle propeller) of the injector jet pipe (IJP), whereas the operation of the valve (SV) and

the operation and rotation of the motor (EM) are controlled by the control system of the gasifier.

6. The control method of the jet gasifier operation, according to claim no. 1 or 2 or 3 or 4 or 5, **characterized in** that the dry steam generator (SG) produces from externally-supplied water a jet of dry steam with the temperature t_{SG} and pressure p_{SG} and that the jet is directed, preferably through a pressure reducing valve (PRV_1), to the steam superheater (SS) where the steam is heated up to a set high temperature t_{PP} , and from the superheater (SS), the steam jet is directed to the supply valve (valve propeller) of the injector jet pump (IJP) where the speed of the jet is increased and its pressure is decreased below the pressure level in the mass feeding system (MFS), which is generally below 1 bar, which allows for sucking the fragmented mass with the jet through the inlet port of the injection jet pump from the mass feeding system (MFS) and then for directing the steam jet mixed with the sucked-in mass to the injector jet pipe (IJP) diffuser where the speed of the jet is decreased and its pressure is increased (but not to exceed the original value of p_{WP}), and from the diffuser the steam jet mixed with the sucked-in fragmented mass is directed, through the outlet port of the injector jet pump (IJP), to the reaction chamber (RC) while simultaneously starting to rapidly heat up the fragmented mass by absorbing the heat of the surrounding steam, which leads to a drop of the temperature of the steam and an increase of the temperature of the fragmented mass and, as the steam jet with the fragmented mass moves through the chamber (RC), the pyrolysis process (degassing of the fragmented mass) starts and quickly reaches the temperature of an exothermic phase from which moment the mass particles heat themselves up and the process is continued at an increasingly high temperature, and the actual gasification process begins, which consists in a reaction between the coal included in the carbonization product, i.e. the solid product of pyrolysis of the fragmented mass, and the steam, which produces mostly carbon monoxide and hydrogen, and the carbonization product is transformed into mineral substances, and as a result of these processes, at the outlet of the chamber (RC), which is hydraulically connected with the inlet port of the ejector jet pump (EJP), a mix of hot gases is produced, which include residual amounts of steam and solid mineral substances and the supply (drive) agent of the ejector jet pump (EJP) is cool water, and the jet of this water is guided to the supply nozzle (nozzle propeller) of the ejector jet pump (EJP) from the pump (WP), preferably through a pressure reducing valve (PRV_2), at pressure p_{WP} , which is higher than the pressure in the reaction chamber (RC) and in the supply nozzle of the ejector jet pump, the speed of the jet of this water is increased and its pressure is lowered below the level of pressure in the chamber

(RC), which allows for sucking in, through the inlet port of the ejector jet pipe (EJP), from the chamber outlet, the mix of gases and solid mineral substances, and after the mix is sucked in by the jet of water, the jet is directed to the diffuser of the ejector jet pump (EJP), where its speed is reduced and its pressure is increased (but not to exceed the original p_{PW} value), and from the diffuser the jet of water, which already contains the cooled gases and mineral substances, is directed to the separation and cooling system (SCS) where, according to known methods, a mix of combustible gases and small quantities of atmospheric gases, mostly nitrogen, are recovered, which are sucked in by the injector jet pump (IJP) together with fragmented mass from the mass feeding system (MSF), and a mix of these gases is purified and directed, through a check valve (CV), to the container (CGC); moreover, in the separation and cooling system (SCS), according to known methods, non-soluble solid mineral substances and carbon dioxide are separated from the water, and the water is cooled and treated to be reused and, if necessary, chemical, non-soluble pollutants are precipitated from the water, and then the water is directed from the separation and cooling system (SCS) to the water pump (WP) and more water is added as required.

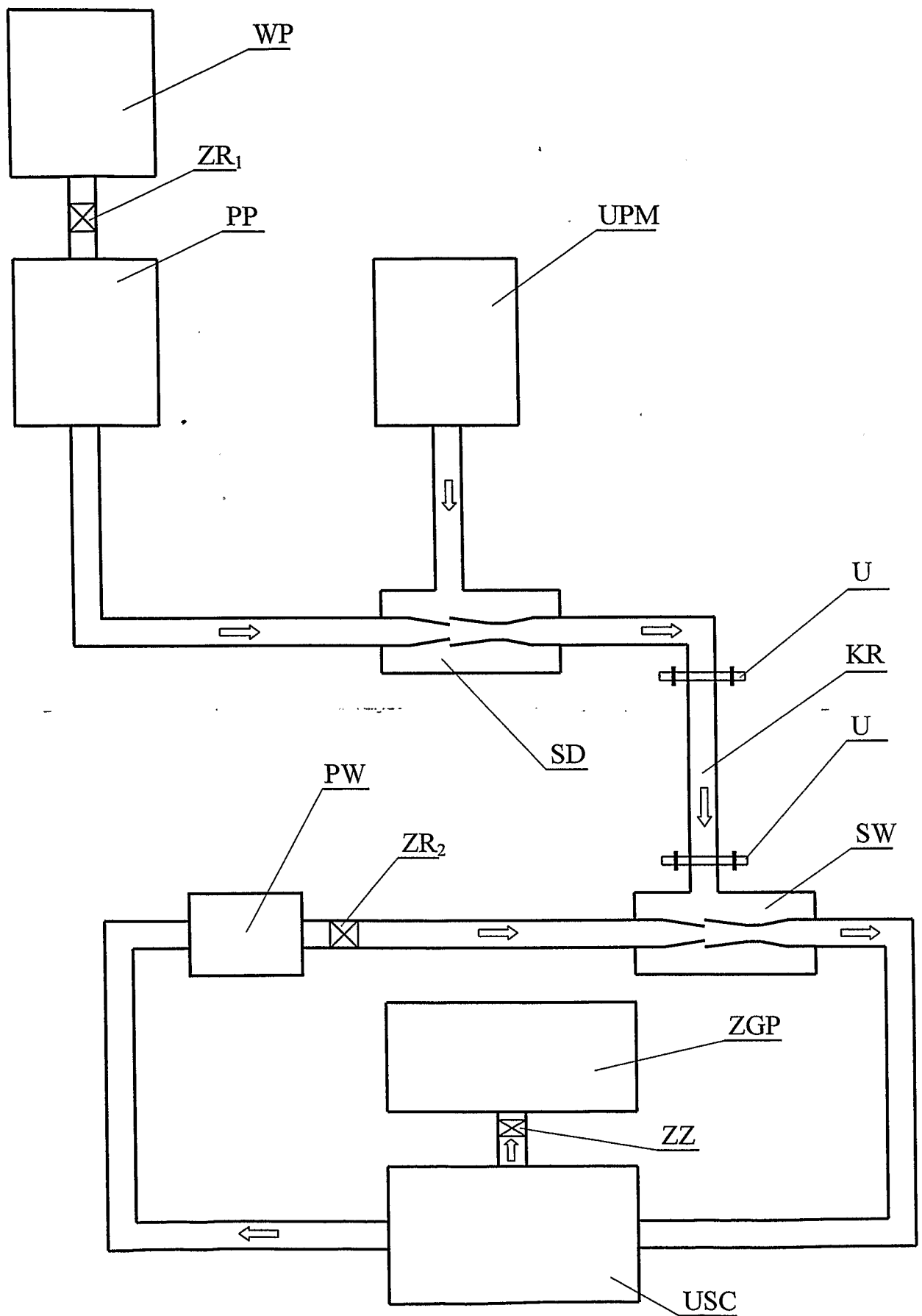


Fig. 1

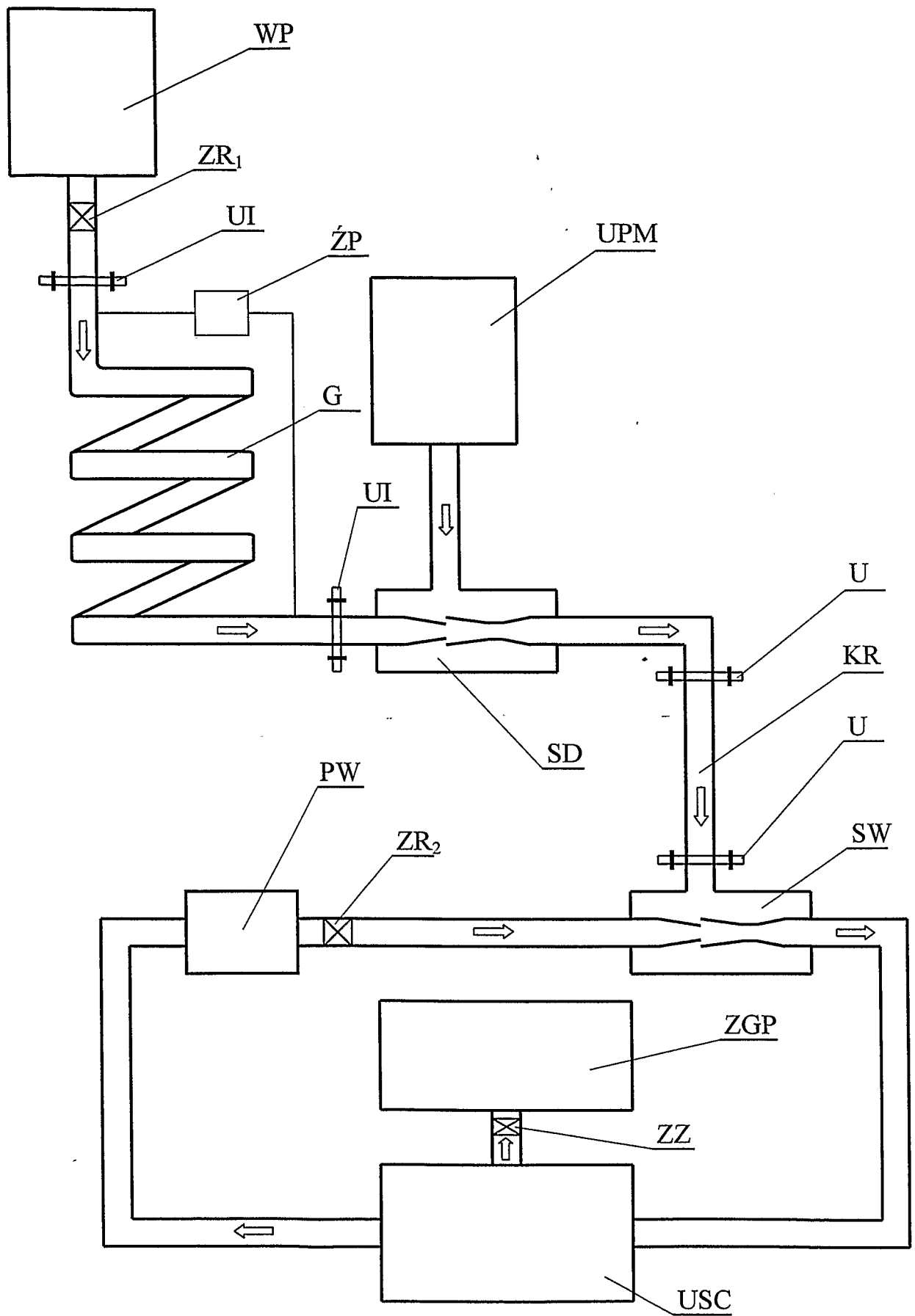


Fig. 2

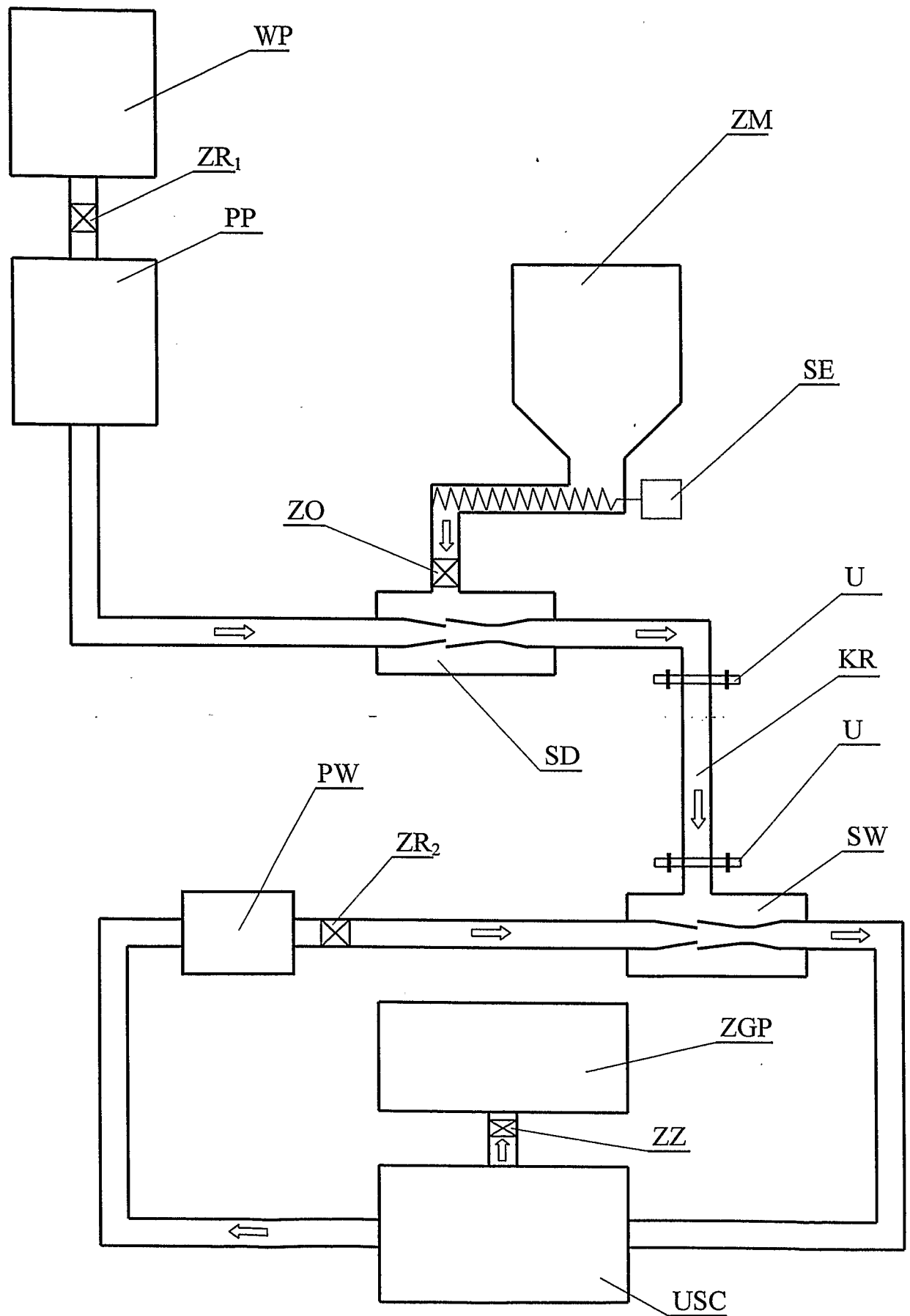


Fig. 3