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UTILIZATION OF EXCESS STEAM AND HOT GASES

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Fig. 1.

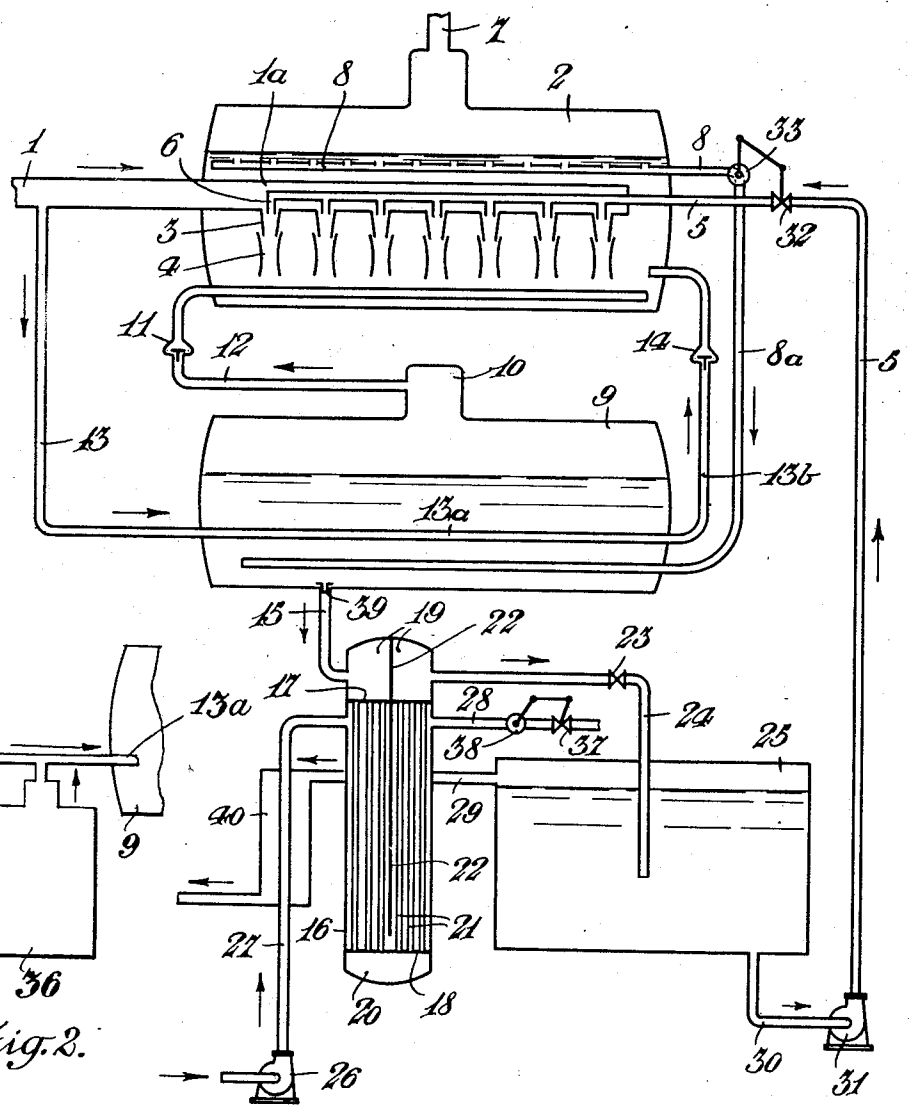


Fig. 2.

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UTILIZATION OF EXCESS STEAM AND HOT GASES

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In blowing off digesters for cellulose and other similar apparatus a great quantity of excess steam is obtained during a short period of time which steam may be utilized for heating water or for other heating purposes, for instance, by being condensed in the usual condensers. Because such excess steam must generally be condensed in a very short time and, moreover, has a falling pressure, the condenser must have great dimensions or the quantity of cooling water be increased to a very high amount. In this latter case the inconvenience arises that the cooling water is heated to a relatively low temperature only and consequently the quantity of heat delivered thereto from the steam cannot be utilized with the same high efficiency. Finally, such exhaust steam generally contains various impurities rendering it difficult to utilize the heat of the condensate obtained.

The chief object of this invention is to utilize such excess steam and also hot gases, such as combustion gases, by use of a simple apparatus of moderate dimensions, to render it possible to use the heat delivered by the steam or gas, also in the intervals, when no excess steam or gas is available and also to eliminate the difficulties met with when the exhaust steam contains impurities. The invention consists, chiefly, in this that the excess steam or hot gas is mixed with a cooling liquid injected therein to produce a hot liquid having a temperature immediately below the boiling point, said hot liquid being then utilized for heating water or another medium in a heat exchanger. In the well-known jet condensers a condensation of steam by direct injection of cooling water is also brought about but so great quantities of cooling water are used for this purpose that the temperature of the liquid obtained becomes too low to permit an advantageous utilization of the heat absorbed. In carrying out the method in accordance with this invention jet condensers of a special design are used calculated for moderate quantities of the cooling medium to give a liquid having the highest temperature possible. In certain cases waste water or other water of low value from the factory having a temperature of 50 to 60° C. is used as a cooling liquid so as to give, per kilogram condensed exhaust steam or hot gas, a greater quantity of liquid having a high temperature and consequently a greater quantity of heat easy to use than when, for instance, cold water is used for the injection.

In one preferred embodiment of my invention no cooling liquid is supplied from the outside but the cooling liquid circulates in the system. Whether a cold or a relatively warm cooling liquid is used the quantity of said liquid supplied may, by preference, be regulated by means of a valve adjusted automatically to give the mixture the highest temperature possible. Preferably, the mixture is transferred to a container or accumulator for hot water, whose outlet is dimensioned in such manner that the accumulator always, i. e. also in the intervals, when no steam is blown off, contains a liquid of a high temperature, which is easy to utilize in the heat exchanger.

Two embodiments of my invention are shown in the annexed drawing showing a plant for utilizing exhaust steam.

Fig. 1 shows an entire plant, partially in section. Fig. 2 shows a modification and its mode of connection to the plant illustrated in Fig. 1.

Referring now to the drawing 1 indicates a pipe, through which exhaust steam, for instance, from a cellulose digester, flows almost entirely into the portion 1*a* of said pipe 1. The portion 1*a* extends into the tank or container 2, is closed at its end and provided with a number of outflow nozzles 3 ejecting into diffusers 4. From the opposite direction a pipe 5 for the cooling liquid enters the tank 2 and the pipe 1. This pipe 5 is provided with a number of outflow nozzles 6 placed centrally one in each of the nozzles 3. Each pair of nozzles 3 and 6 forms an ejector, in which the excess or exhaust steam and the cooling liquid are effectively mixed and the steam condensed. To increase the cooling surface the nozzles 3 may be connected by tubes to the pipe 1*a*, the main pipes 1*a* and 5 being then placed on a higher level in the tank or outside the same. The tank 2 is pro-

vided with an outlet pipe 7 for non-condensible gases and with a perforated overflow pipe 8, which extends throughout the total length of the tank and via a pipe 8*a* is connected with an accumulator 9 for the hot mixture of liquids formed. In the pipe 5 for the cooling liquid a valve 32 is inserted automatically operated by a thermostat 33 in the pipe 8 in such manner that the quantity of cooling liquid fed into the container 2 through the pipe 5 is regulated in agreement with the temperature of the mixture of liquid blowing off from the container 2 through the pipe 8. The accumulator 9 has a steam dome 10, from which a steam pipe 12 having a back pressure or non-return valve 11 discharges at the bottom of the container 2. A branch pipe 13 for steam is branched off from the main steam pipe 1 and connected with a heating tube 13*a* in the accumulator 9 for the hot mixture of liquids said tube being connected with the lower portion of the container 2 via on outlet tube 13*b* having a non-return or check valve 14.

The liquid space of the accumulator 9 is connected with a heat exchanger by a tube 15 having a filter 39, this exchanger in the embodiment shown consisting of a cylinder 16 divided by partition walls 17, 18 into a central chamber, an upper chamber 19 and a lower chamber 20, the two latter chambers being interconnected by tubes 21. In the cylinder 16 a central partition 22 is provided, dividing the upper chamber 19 into two parts and ending in the central chamber close above the lower partition wall 18, as illustrated. The hot mixture of liquids from the tube 15 flows into the left part of the chamber 19 and downwards through the tubes 21 on the left side of the partition wall 22 into the lower chamber 20 and from there upwards through the tubes 21 on the right side of the partition wall 22 into the right half of the chamber 19 and is discharged through a tube 24 having a valve 23 into a container 25 for the cooled condensate. Cold water is forced by the pump 26 through the pipe 27 into the left half of the central chamber of the cylinder 16 and farther round the lower edge of the partition wall 22 into the right half of the same chamber, and this water is heated by the tubes 21. This heated water is drawn off through the pipe 28. Though the exhaust steam from the pipe 1 contains impurities which may render it impossible to utilize the mixture of liquid formed for some heating purposes, the hot water from the pipe 28 is quite pure and may be used for all heating purposes. As stated above, waste water or other water from the factory having a temperature of about 40 to 50° C. may be used as a cooling liquid in the container 2. It is, however, also possible to make the cooling liquid circulate in the system and still have it cooled to a temperature not lower than that just mentioned. In both cases greater quantities of heat are recovered than in the case that cold water is used for condensing the exhaust steam. If the cooling liquid is caused to circulate, i. e. if condensate from prior exhausts is used as a cooling liquid, the further advantage is attained that this condensate is enriched in the constituents or impurities contained in the exhaust steam. Thus, if the exhaust steam contains valuable constituents, this being the case for instance in digesting cellulose by the sulphate method, such constituents may more easily be recovered. Such a circulation of the condensate is shown in the embodiment illustrated. For this purpose the container 25 has an overflow pipe 29 and an outlet pipe 30, into which a pump 31 is inserted to return the cooled condensate through the pipe 5 to the container 2, in which the condensate is used as a cooling liquid for a new quantity of steam, at the next exhaust, as stated above.

To control the temperature of the hot water drawn off through the pipe 28 a valve 37 is provided which is automatically operated by a thermostat 38 in the same pipe.

If the cooled mixture of liquids flowing to the container 25 through the pipe 24 has a temperature substantially exceeding the temperature of the cooling water in the pipe 27 a further part of the heat of the liquid in the container 25 may be recovered by conducting the excess liquid from the overflow pipe 29 through a pre-heater 40 heating the water in the pipe 27. In plants in which the condensate circulates through the system, as illustrated in the drawing, the quantity of liquid discharged through the overflow pipe 29 is equal to the quantity of steam supplied and consequently amounts to a relatively small part of the quantity of circulating liquid. Thus, a further quantity of heat may be recovered by use of the comparatively small heat transmitting surface represented by the pre-heater 40 or the total heat transmitting surface may be considerably reduced by use of such an additional pre-heater without reducing the thermal efficiency of the whole plant.

The device described is operated as follows:

The exhaust steam enters through the main pipe 1 during a comparatively short period and its greater part flows into the part 1*a* of this main pipe and farther through the nozzles 3 into the container 2 which is in advance filled with cooled condensate from a prior exhaust to a suitable level through the pipe 5. During the course of the exhaust the valve 32 controlling the temperature of the mixture formed is opened automatically and admits cooling liquid continuously through the nozzles 6. Then the exhaust steam is mixed with the cooled condensate to form a mixture of liquids having a temperature immediately

below the boiling point, if the ratio of the quantity of steam to the quantity of cooled condensate (cooling liquid) is chosen correctly. The container 2 must, of course, be dimensioned in such manner that a satisfactory control of the temperature is attained, but as a rule need not hold the total quantity of hot mixture of liquids formed during one exhaust. This hot mixture is discharged through the outflow pipe 8 to the accumulator 9, which will hold the total quantity of hot mixture of liquids formed during one exhaust and in which the liquid will be on its lowest level at the beginning of each exhaust period and rise to its highest level during and shortly after the exhaust and fall slowly to its lowest level again in the interval between two exhausts. From the accumulator 9 the hot mixture of liquids is drawn off continuously during the exhaust periods as well as during the intervals between them through the pipe 15 to the heat exchanger 16, in which it is cooled to be afterwards discharged into the container 25 for cooled condensate, in which it is accumulated to be used as a cooling liquid in the container 2 at the next exhaust. The excess of cooled condensate is drawn off from the container 25 through the outflow pipe 29 and the pre-heater 40.

The hot mixture of liquids flowing continuously through the cylinder 16 heats a current of cooling water, which is as well continuous and drawn off as hot water through the pipe 28. The intermittent exhaust of steam made at comparatively long intervals is thus utilized for a substantially constant generation of hot water.

A small portion of the exhaust steam from the main pipe 1 flows via the branch pipe 13 and the pipe 13*a* through the accumulator 9 to heat the hot mixture of liquids in it to compensate for losses of heat due to radiation. From there this steam flows via the pipe 13*b* and the non-return valve 14 into the container 2 to be condensed there. The heating caused by the steam in the pipe 13*a* concurs to keep the condensate in the accumulator 9 at a temperature immediately below the boiling point.

In the modification shown in Fig. 2 a steam accumulator 36 is shunted to the pipe 13 between the steam supply pipe 1 and the accumulator 9 for the mixture of hot liquids formed. In the shunt pipe 35 from the pipe 13 to the accumulator 36 a non-return valve 34 is provided. In this case a portion of the steam in the branch pipe 13 will flow into the accumulator 36 via the pipe 35 particularly during the first part of the exhaust period, the pressure being then highest, and is accumulated in this accummulator to be delivered to the tubes 13, 13*a*, after the pressure of the exhaust steam has decreased again. The steam thus accumulated then delivers heat in the pipe 13*a* in the accumulator 9 and flows to the container 2 through the pipe 13*b*. Thus the steam accumulator 36 levels the current of steam through the branch pipe 13.

Steam generated in the accumulator 9 or flowing into this accumulator together with the hot mixture of liquids through the pipe 8*a* is let out from the steam dome 10 through the pipe 12, if its pressure rises too much, and passes through the back pressure valve 11 to the container 2 to be condensed.

The valves 32 and 37 automatically adjusted by the thermostats 33 and 38 control the water currents in the pipes 5 and 28, respectively, in such manner that the temperatures of the hot mixture of liquids discharged through the pipe 8 and of the hot water drawn off through the pipe 28 are maintained at constant values. The valve 23 is adjusted by hand or automatically in accordance with the level in the accumulator 9 to make the current of condensate through the heat exchanger 16 as constant as possible.

It is to be observed that the less the temperature of the cooled condensate supplied to the container 2 through the pipe 5 is, the less is the quantity of such condensate necessary for condensing a certain quantity of steam, and on equal conditions in other respects the sizes of the jet condenser 3, 6, the pump 31 and the containers 2, 9 and 25 may be reduced accordingly. It is, therefore, very important that the heat exchanger 16 is as efficient as possible to cool the condensate to a low temperature.

Some modifications may be made in the devices described and illustrated without leaving the scope of the invention. Thus, the pipe 13*a* may be perforated and the pipe 13*b* be omitted, the steam entering the accumulator 9 through the pipe 13*a* being then drawn off to the container 2 via the pipe 12. The whole piping 13, 13*a*, 13*b* may be omitted. An outlet pipe from the bottom of the container 2 to the accumulator 9 may be provided to render it possible to empty the container 2 after the exhaust, before cooled condensate is let into this container 2 for the next exhaust. All valves may be automatic. The heat exchanger may be of any suitable design. It is obvious that also non-condensable hot gases, such as combustion gases, may be caused to give off their heat in the apparatus described, though, of course, no condensation takes place in this case. This method of utilizing hot in-condensable gases is advantageous substantially for such gases having a moderate temperature. Such gases having high temperatures are, by preference, utilized in economizers or the like.

What I claim is:—

1. In a device for utizilizing condensable and non-condensable hot gases containing im-

purities, for heating purposes, a jet condenser, a pipe for supplying a cooling liquid to said condenser, a valve in said pipe means for adjusting said valve automatically to give the hot liquid formed in said condenser a temperature immediately below the boiling point thereof, a heat exchanger having two spaces separated by heat transmitting walls, a pipe for passing the hot liquid from said condenser through one of said spaces in said heat exchanger, and a pipe for passing a second, substantially pure medium through the other of said spaces.

2. In a device for utilizing condensable and incondensable hot gases containing impurities, for heating purposes, a jet condenser, a pipe for supplying a cooling liquid to said condenser, a regulating valve in said supply pipe, means for adjusting said valve automatically to give the hot liquid formed in said condenser a temperature immediately below the boiling point thereof, an outlet pipe from said condenser for the hot liquid formed, an accumulator in said outlet pipe, a heat exchanger having two spaces separated by heat transmitting walls, a pipe for passing the hot liquid from said accumulator through one of said spaces, and another pipe for passing a second, substantially pure medium through the other of said spaces.

3. In a device for utilizing hot gases containing impurities, for heating purposes, a jet condenser, a container surrounding said jet condenser, a pipe for supplying a cooling liquid to said condenser and to said container to fill the latter to a certain level, a regulating valve in said supply pipe, means for adjusting said valve automatically to give the hot liquid formed in said condenser and container a temperature immediately below the boiling point thereof, a heat exchanger having two spaces separated by heat transmitting walls, a pipe for passing the hot liquid from said condenser through one of said spaces in said heat exchanger, and a pipe for passing a second, substantially pure medium through the other of said spaces.

4. In a device for utilizing hot gases containing impurities, for heating purposes, a jet condenser, a pipe for supplying a cooling liquid to said condenser, a regulating valve in said supply pipe, means for adjusting said valve automatically to give the hot liquid formed in said condenser a temperature immediately below the boiling point thereof, a heat exchanger having two spaces separated by heat transmitting walls, a pipe for passing the hot liquid from said condenser through one of said spaces, a pipe for passing a second, substantially pure medium through the other of said spaces, and means for returning the cooled liquid from the first one of said spaces to said supply pipe.

5. In a device for utilizing hot gases containing impurities, for heating purposes, a jet condenser, a pipe for supplying a cooling liquid to said condenser, a regulating valve in said supply pipe, means for adjusting said valve automatically to give the hot liquid formed in said condenser a temperature immediately below the boiling point thereof, a heat exchanger having two spaces separated by heat transmitting walls, a pipe for passing the hot liquid from said condenser through one of said spaces, a pipe for passing a second, substantially pure medium through the other of said spaces, a tank for the cooled liquid from the first one of said spaces, and means for returning the cooled liquid from said tank to said supply pipe of said condenser.

6. In a device for utilizing excess steam containing impurities and available during short periods at long intervals, for heating purposes, a jet condenser, a pipe for supplying a cooled liquid to said condenser, a regulating valve in said supply pipe, means for adjusting said valve automatically to give the hot mixture of liquids formed in said condenser a temperature immediately below the boiling point thereof, an outlet pipe for said hot mixture from said condenser to an accumulator, a heat exchanger having two spaces separated by heat transmitting walls, a pipe for passing the hot mixture from said accumulator through one of said spaces into a tank, another pipe for passing a second, substantially pure medium through the other of said spaces, means for returning the cooled mixture from said tank to said supply pipe of said condenser, an overflow pipe from said tank, and a preheater in said overflow pipe to preheat said second medium.

7. A method of utilizing condensable and incondensable hot gases containing impurities, for heating purposes, comprising injecting a cooling liquid into said gases, controlling the quantity of said cooling liquid automatically in such manner as to produce a hot liquid having a temperature immediately below the boiling point of said liquid, separating said hot liquid from the gases remaining incondensed, if any, and passing said hot liquid through a heat exchanger to heat a second, substantially pure medium indirectly.

8. A method of utilizing condensable and incondensable hot gases containing impurities, for heating purposes, comprising injecting water of low value from a factory into said gases, controlling the quantity of said water automatically in such manner as to produce hot water of a temperature immediately below its boiling point, separating said hot water from the gases possibly remaining incondensed, and passing said hot water through at heat exchanger to heat a second, substantially pure medium indirectly.

9. A method of utilizing hot gases and vapors containing impurities, for heating purposes, comprising injecting into said

gases, water of a temperature substantially not exceeding 60° C. from a factory, controlling the supply of said water automatically in such manner that said water is heated to substantially 95° C., separating said hot water of about 95° C. from the gases possibly still incondensed, and passing said hot water through a heat exchanger to heat a second, substantially pure medium indirectly.

10. A method of utilizing excess steam containing impurities and available during short periods at long intervals, for heating purposes, comprising condensing said steam by direct injection of waste water of moderate temperature substantially not exceeding 60° C., controlling the supply of said water automatically so as to form a hot mixture of condensate and water having a temperature of about 95° C., separating said hot mixture from any gases still incondensed, and passing said hot water, without any admixture of a cooler medium, through a heat exchanger to heat a second, substantially pure medium indirectly.

In testimony whereof I have signed my name.

CURT ROSENBLAD.