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May 25, 1926.

1,585,791

J. RUTHS

STEAM PLANT

Filed April 29, 1925

2 Sheets-Sheet 1

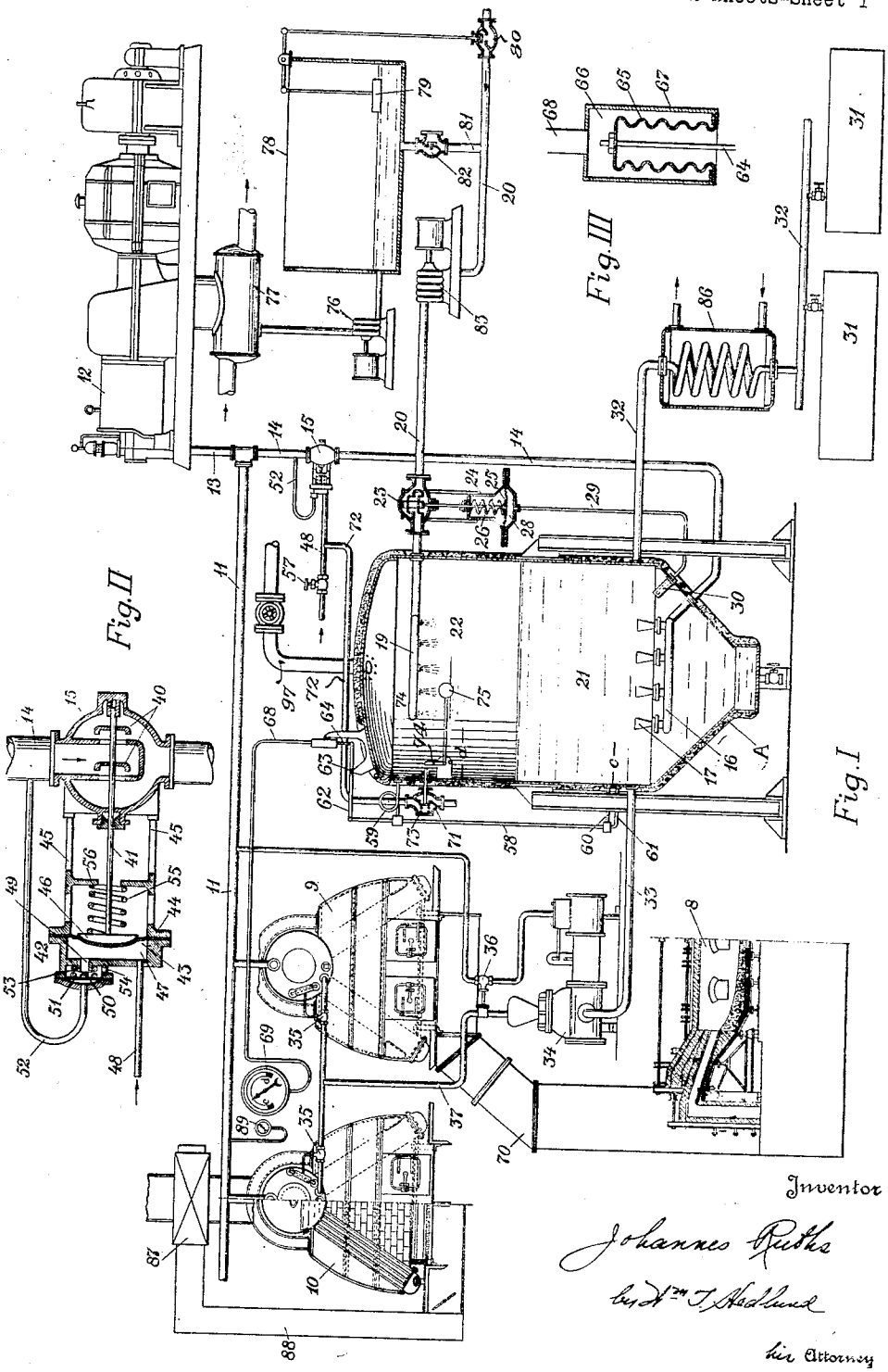


Fig. I

Fig. II

Fig. III

Inventor

Johannes Ruths

by Wm. T. Hedlund

his Attorney

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2 Sheets-Sheet 2

Fig. IV.

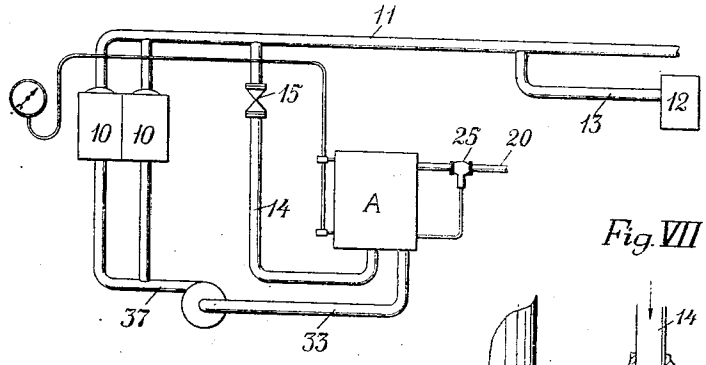


Fig. V.

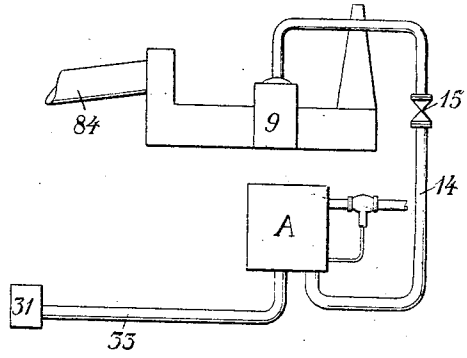


Fig. VII

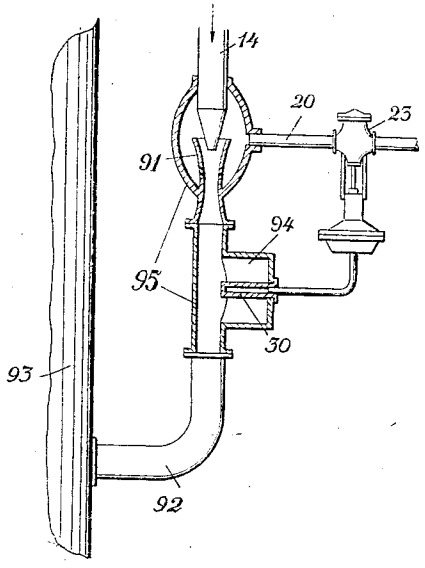
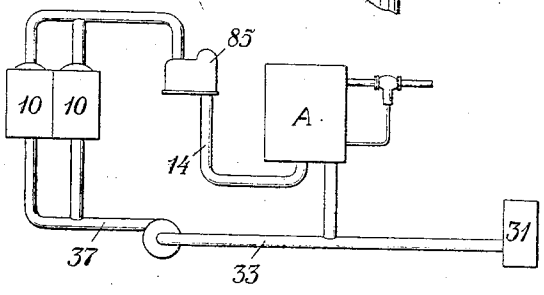


Fig. VI.



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Patented May 25, 1926. 1,585,791

UNITED STATES PATENT OFFICE.

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STEAM PLANT.

Application filed April 29, 1925. Serial No. 26,727.

My invention relates to the accumulation of heat in steam plants, and more particularly to the accumulation of hot water for use as feed water or for industrial purposes. My invention involves a new method of producing and dispensing heat energy in steam plants, which comprises generating steam of constant pressure at a rate always or substantially always higher than the rate of steam consumption and independently of steam or hot water consumption; condensing the surplus of steam generated over that consumed by means of cold water; regulating the amount of condensing water so that the condensed water is at a constant desired temperature; storing the hot water thus prepared and withdrawing the same as desired for use as feed water for boilers or for hot water use in industrial processes, etc. My invention further involves the apparatus for carrying this method into effect.

Amongst the purposes of my present invention are: to equalize between heat generation and heat consumption in a steam plant particularly where variations are such that equalization can be effected through feed water reserve or where there is a demand for hot water for industrial purposes; to increase production in a steam plant; to increase efficiency of a steam plant; to take care of variable supply of heat to a boiler; and to maintain constant pressures in all the various parts of a plant.

By the present invention an accumulator can be built which is smaller and less costly than the known steam accumulator of variable pressure; boiler firing can be made entirely independent of consumption of steam or hot water; hot water is aways in reserve in any desired quantity, and of given constant temperature; boilers can be run with the best efficiency and other advantages are obtained as will be apparent from the description following.

My invention also involves certain features such as methed and means for regulating boiler fires in a plant as herein set out and a safety arrangement for high water level in the accumulator.

Other purposes and features of the invention will be apparent as the description proceeds which is to be taken in connection with the accompanying drawings wherein:—

Figure I shows a plant according to the present invention and including the essential features necessary to carrying out the operation as herein set forth.

Figure II shows details of one form of overflow valve used in the plant of Figure I.

Figure III shows a detail of an indicating device used in the plant of Figure I.

Figure IV shows a simplified form of plant embodying my invention wherein hot water is prepared solely for use in boilers.

Figure V shows diagrammatically a simplified form of plant wherein hot water is prepared solely for industrial use.

Figure VI shows a plant wherein a motor is inserted between boilers and accumulator to extract power from the steam pressure drop between the two.

Fig. VII shows a modified arrangement of hot water preparing apparatus.

My invention is applicable to steam plants having any kind of boilers or producing steam in any manner. For purposes of illustration I have shown in the steam plant of Figure I a steam generator comprising two boilers; a boiler 10, the firing of which is adapted to be regulated by a fire room force, the particular boiler shown being fired with coal; and a second boiler 9 the heat supply to which is not adapted to be regulated to any great degree, the boiler shown consisting of a waste heat boiler supplied with hot gases leaving open-hearth furnace 8 and supplied to the boiler through waste heat conduit 70. The steam generated in the steam generator passes into steam conduit 11, from which a part of the steam generated passes through conduit 13 to a steam consumer 12 which may be of any type, the drawing showing, for sake of illustration, a condensing turbo-generator set. The remainder of the steam passes through conduit 14 to the accumulator A.

Inserted in the conduit 14 is an overflow valve 15. This valve is controlled by the pressure in front of the same which in the case illustrated is the boiler pressure and also the supply pressure for the consumer 12. The valve 15 operates to maintain a constant pressure in conduits 11 and 13, and allows the surplus of steam generated over what is used by consumer 12 to pass into accumulator A where it is condensed by

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cold water and in which hot water formed from the mixture of steam and cold water is stored.

A designates my novel heat accumulator which might be termed a "constant temperature, variable water level accumulator" since it is a characteristic feature of this accumulator that in normal operation its temperature is maintained constant and the water level in the same varies in accordance with the amount of heat stored in the same.

The accumulator may be made in a number of ways. As an example of one way of making the same I have shown a vertical cylindrical receptacle which is suitably supported in any desired manner. The accumulator has a steam space 22 and a water space 21, the volume of which vary as the water level varies. The accumulator is preferably designed so that it can receive and store all the surplus steam regardless of the amount of the same: that is, the accumulator should be designed so that it can always receive and store the difference between what is generated by boilers and what is consumed by consumers connected in front of the overflow valve, regardless of how large this difference may be. This matter depends however on the manner in which it is desired that the boilers be fired. By greater variation of fire intensity smaller accumulators can be used. However, having in mind independence of boiler firing and steam and heat consumption the accumulator will be designed most rationally if it is of sufficient capacity so that none or very slow changes of fire intensity under the boilers need take place, or, where the heat to the boilers is supplied by waste gases, so that no gases need be thrown away or so that manually controlled boilers working in connection with waste heat boilers need not be fired too unevenly.

Steam enters the accumulator through the steam charging device 16 which, in the illustration shown, comprises a circular steam loop to which is attached a series of nozzles 17. This charging device lies in the water space 21 of the accumulator.

Cold water is supplied to the accumulator through the cold water supply pipe 20, and is sprayed into the steam space of the accumulator through the cold water spray device 19. The amount of cold water supplied through pipe 20 is regulated so that a constant temperature is maintained in the accumulator A. This is accomplished by means of a cold water regulating valve 23, which is controlled by an actuating mechanism 24 comprising a diaphragm 25, which diaphragm is influenced on the one side by a spring 26, and on the other side by the pressure of a volatile liquid in chamber 28. Tube 29 connects chamber 28 with a thermostat 30 which is situated in the accumulator, preferably in the water space thereof. The thermostat may be of any known kind comprising a casing enclosing volatile liquid.

As steam enters the accumulator through conduit 14 and charging device 16 the temperature increases a very small amount. The volatile liquid in thermostat 30 then expands and the increase of pressure due to expansion is transmitted to diaphragm 25 which moves the discs of valve 23 upwardly, thus opening more or less the valve 23, allowing cold water in increased amount to enter the steam space 22 through spray device 19 thus condensing steam and lowering the temperature by the small increment of increase so that the temperature is returned to its normal value. The arrangement thus maintains a practically constant temperature in the accumulator.

Hot water may be extracted from the accumulator for various purposes. For industrial purposes I have shown hot water consumers 31 connected to receive hot water from the accumulator by means of hot water conduit 32. The hot water consumers 31 may, as is obvious, be of any kind, for example dye vats, washing machines and the like. I have shown a heat exchanger 86 of the indirect type inserted between the accumulator and consumers 31 since with the arrangement of Fig. I, I plan to have the temperature in the accumulator higher than that used by consumers 31 and the exchange thus takes out heat from the hot water before its pressure is lowered. The arrangement of consumers is immaterial to the present invention and depends upon the particular plant.

For boiler feeding hot water is extracted through the feed conduit 33 by means of pump 34, and fed into the boilers, the amount being regulated in any desired manner. This may be accomplished as diagrammatically indicated on the drawing by means of valves 35 controlled by water level in the respective boilers in combination with the valve 36 in the steam supply pipe to the pump controlled by pressure in the feed water supply pipe 37.

I consider my present invention of particular importance for boiler feeding as it provides hot water of constant temperature and in many cases at a temperature not a great deal under boiler temperature, thereby allowing the heat of off-take gases to be recovered in air preheaters which gives higher efficiency than economizers. By combining this advantage with that of independence of heat generation and heat consumption my invention provides a highly efficient plant.

In Fig. I, 87 designates an air preheater for the boiler 10 which may be of any desired kind, supplying hot air to the furnace of the boiler through conduit 88.

Figure II shows details of construction of one form of overflow valve adapted to be used with a plant laid out in accordance with the present invention. The valve comprises a casing enclosing a set of discs 40 forming what is known as a balanced valve. The valve discs are attached to a spindle 41 which is connected to an operating mechanism 42 which operating mechanism comprises a diaphragm 43 firmly connected to a housing 44 which is secured to the main valve casting by means of legs 45. Diaphragm 43 is attached at its center to the end of spindle 41, and rests against a backing plate 46 also attached to the spindle. The diaphragm 43 forms one side of a chamber 47 to which an operating fluid is conducted through a restricted pipe 48. This operating fluid may be of any kind whether gaseous such as air, or liquid such as water or oil.

The operating fluid leaves chamber 47 through an orifice 49 controlled by a checking member 50 attached to a second diaphragm 51, which is influenced, on the one side, by the pressure in conduit 14 in front of the valve 15, the pressure acting through tube 52, and on the other side by the combined influence of the actuating fluid leaving the orifice 49, and a spring 53. The operating fluid leaves the housing and is allowed to flow into the air or other exhaust means through port 54. A spring 55 extends between backing plate 46 and fixed abutment 56.

The operation of the valve is as follows:—

Suppose the valve 15 is in the position indicated on the drawing. Now suppose that the pressure in conduit 14 ahead of the valve rises somewhat. The increase of pressure is transmitted through tube 52 onto diaphragm 51, which is moved against the action of spring 53 to throttle the orifice opening 49. This causes an increase of pressure in chamber 47 whereby diaphragm 43 is moved against the action of spring 55 so that the valve discs 40 are caused to move to open the valve more and allow more steam to pass through, which allows the pressure in conduit 14 ahead of the valve to fall, whereby returning it to the desired constant pressure.

Suppose, on the other hand, that the pressure falls in conduit 14 ahead of the valve. The diaphragm 51 then causes member 50 to move away from orifice opening 49 due to the preponderance of force of spring 53 added to the pressure of fluid leaving the orifice opening over the pressure exerted through tube 52, whereby, due to the restriction in pipe 48, shown in Figure I as a hand valve 57, the pressure decreases in the chamber 47 and spring 55 overcomes the opposing effect of fluid pressure in chamber 47, and valve discs 40 are moved to close the main valve whereby the pressure in conduit 14 before the valve is returned to normal. By this means a constant or substantially constant pressure can be maintained in conduits 11, 13 and in the boilers.

When the consumer 12 is such that steam used by the same can be condensed and is in proper condition to be used as feed water or for certain industrial purposes, the same may be led into the accumulator A to be fed to the boilers or used as hot water. The means which I show for doing this include motor driven pump 76 which draws condensate from condenser 77 and leads the same into container 78. In the container 78 is a float 79 which operates when the level in container 78 falls below a predetermined value to open valve 80 in cold water conduit 20. Water is drawn by pump 83 through pipe 81 and check valve 82 into conduit 20, and is supplied to the accumulator A. By this means the pump 83 always takes the water from container 78 first and only secondarily from the outside cold water supply. For this operation, as is obvious, the supply pressure from the outside source must be greater than the height of water in the container 79. This arrangement permits the storing of the water in the container 78 at times when there is so much steam used by consumer 12 that very little passes through overflow valve 15. It is obvious that at such times the greatest quantity of steam is condensed in condenser 77, but if a constant temperature is to be maintained in accumulator A, very little cold water must be fed thereto, since very little steam at that time is going into the accumulator. Condensed water is therefore stored up in container 78, and led to the accumulator later when there is less demand for steam so that more passes into the accumulator to be condensed.

The present invention presents an advantage over plants containing an accumulator of variable pressure that special designs of turbines to take steam from accumulators can be avoided.

Further there is no restraint on the amount of steam generated. With some systems now in use steam is used to heat feed water but there is always a restraint put on the boilers. A close regulation of fires is necessary. Such systems regulate the amount of steam supplied to heat cold water and when the momentary amount of hot feed water is obtained at the proper temperature, the steam supply is shut off and boiler fires must be reduced in intensity in corresponding degree. My system however puts no such limitation on the boilers. Steam may be generated in any desired amount at all times and the difference between generation and consumption will always be accumulated.

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Furthermore, by means of the overflow valve the advantage of constant pressure in the boilers is obtained. It is always considered evidence of good working in a boiler house when the boiler pressure diagrams approximate as closely as possible to straight lines. This gives constant pressure for auxiliaries and for main engines, high efficiency of boilers, evenness of control of water level in boilers and other recognized good operating points.

With constant boiler pressure, no accumulation reserve remains in the steam boilers but this is well taken care of by the accumulator.

As stated the manner of firing the boilers depends somewhat on the type of plant. While the accumulator could be designed of sufficient size to take care of all variations with even firing of boilers, it will probably be found most suitable in the majority of cases to vary the boiler firing along slow gradually changing curves.

With the overflow valve as herein used the boiler pressure never varies, the gage 89 always showing a constant value regardless of conditions of steam reserve in the plants so that the fires cannot be regulated as in an ordinary steam plant but some other means must be used to vary the boiler firing.

To take care of this matter I propose to control the fires in a manner somewhat similar to the method of controlling the fires in a plant equipped with a steam accumulator of varying pressure as set forth in my copending application Serial No. 305,622, Patent No. 1,585,790.

That method comprises regulating the fires in accordance with extreme values of steam pressure in the accumulator. While in the variable pressure steam accumulator of the above mentioned application the steam pressure is a function of a state of charge, in the constant temperature, variable water level accumulator of this application, the height of water in the accumulator is a function of the state of charge, wherefore I propose herein to use the height of water level in the accumulator as a factor for regulating the fires.

To this end Figure I shows means for indicating in the vicinity of the coal fired boiler 10, the height of water level in the accumulator A. This means comprises a vertically posited tube 58 of any suitable expansible metal which is connected to the steam space 22 and the water space 21 of the accumulator A, by means of tubes 59 and 60 respectively. The lower end of tube 58 is firmly fixed as by means of bracket 61 firmly secured to the accumulator shell. The upper end moves in response to changes of temperature due to changes of water level in the accumulator A, and consequently in the tube 58. The upper end of the tube 58 being movable, tube 59 is supplied with a loop to take care of expansion. Movement of the upper end of tube 58 is transmitted by means of lever 62 pivoted at point 63 to a rod 64 which is connected to an expansible member 65 shown in Figure III. The expansible member 65 which may be an inverted flexible metal bellows is so mounted that its movement will change the volume in chamber 66 between the bellows 65 and cylinder 67. In the chamber 66 and pipe 68 is a non-compressible liquid which acts as an agency for transmitting movement of the free end of bellows 65 to a suitable indicating means on the dial gage 69 placed in the vicinity of the boiler 10.

The mode of operation of this apparatus will be readily understood to those skilled in the art without extensive explanation. If the water level in accumulator A recedes, rod 58 expands and rod 64 is moved downwardly whereby liquid passes from pipe 68 into chamber 66, and the dial on gage 69 is moved to indicate the corresponding movement of liquid in pipe 68. The dial on gage 69 can thus be moved to indicate the actual water level in the accumulator A. This dial is preferably graduated to show a range of water levels where the intensity of the fires are unchanged, for example between water levels *c* and *d*. When gage 69 shows the water level higher than *d* the fires in boiler 10 are slowly checked until the water level again recedes. If the water level falls below value *c* the intensity of the fires is slowly increased, so that more steam is supplied to the accumulator A, and the water level returns to the normal range. In the meanwhile in the plant shown in Figure I the firing of boiler 9 is allowed to proceed as gas is received from the waste heat supply conduit 70.

In case the water should for some reason rise to too high a level in the accumulator, it may be well to shut off the supply of steam thereto. This will increase the pressure in the high pressure line and therefore the boiler pressure, possibly blowing the safety valves. This is a condition that should not be expected to happen, but may be well as a sort of safety measure to apprise the attendants in the fire room when the water is unduly high in the accumulator. For this purpose I show in Figure I, a valve 71 which controls a conduit 72 branched into conduit 48. Pressure of the operating fluid in the conduit 72 together with the action of spring 73 keep valve 71 normally closed. The valve stem of the valve 71 projects into the accumulator and is adapted to be contacted by a lever 74, which is connected to a float 75, so that when the float is lifted by the water to a predeter-

mined liquid level, the lever 74 moves the valve stem outwardly whereby the valve is open and the pressure of the fluid acting in chamber 47 of the valve housing 44 connected with the overflow valve 15 is released, whereby spring 55 moves the overflow valve to closing position, thus shutting off the steam supply to the accumulator.

In the plant shown diagrammatically in Figure IV, I use my hot water accumulator A simply to feed water to the boilers. Such a plant is possible where the variations in steam consumption are not great and yet a complete equalization can be obtained in the plant.

Figure V shows an arrangement where a waste heat boiler 9 supplied with gases from an industrial furnace for example a rotary kiln 84 supplies steam to the hot water accumulator from which water is extracted only for industrial purposes. In this case there is no steam consumer connected ahead of the overflow valve, and the overflow valve in this case serves merely to keep a constant pressure in the boilers while allowing passage through the same of the variable amount of steam generated. The overflow valve in this case allows a lower pressure in the accumulator than in the boilers, and yet maintains a constant boiler pressure regardless of variation in steam productions.

In the plant diagrammatically illustrated in Figure VI a motor such as a turbine 85 is inserted between the boiler 10 and the hot water accumulator A. This is adaptable for cases where it is desired to run the accumulator at an appreciably lower pressure than that of the boilers, in which case the turbine 85 extracts power from the pressure drop between the boiler and the hot water accumulator.

As shown in Figure VII the mixing of steam and cold water to form hot water need not take place in the accumulator itself, but may take place in a separate receptacle, and then led to the accumulator and stored. In the arrangement shown in Figure VII, steam is supplied to the receptacle 95 through conduit 14 and water through conduit 20 controlled by valve 23 in response to temperature as in Figure I. Steam passes into nozzle 91 carrying water with it, and is condensed thereby. The hot water thus prepared then passes through conduit 92 and into the storage reservoir 93 of the accumulator apparatus. The thermostat in this case is placed in a pocket 94 arranged in the conduit 92. In such a case the water level in the accumulator reservoir 93 will vary in the same manner as in the accumulator of Fig. I.

This separate preparation of the hot water may also be accomplished by using a receptacle built in manner similar to the accumulator A but of much smaller size which serves, like the receptacle 95 to prepare the hot water which is then conducted to a larger receptacle in which it is stored.

As is obvious to those skilled in the art various changes in construction and operation are possible within the scope of the invention.

Although always preferable, in some cases the overflow valve may be omitted or other mechanisms may be substituted for the same.

The present application is to be considered as relating back for all common subject matter to the filing date of my copending application Ser. No. 611,535 filed January 8th, 1923, and to the rights incident thereto.

As pointed out in that application, steam may also be extracted from the accumulator. In the embodiment shown in Fig. I, this may be done through conduit 97. This operation might cause a temporary drop of temperature in the accumulator. This action I consider as within the scope of my invention and not in variance with the basic idea of constant temperature accumulation. Accumulation may be effected in combined constant temperature and variable pressure manner.

Having particularly described and ascertained the nature of my invention and the manner in which the same is to be performed, what I claim and desire to protect by Letters Patent of the United States is:—

1. In a steam plant including a steam generator, in combination, an accumulator, means to supply surplus steam generated over momentary steam demand to said accumulator, means to supply cold water to said accumulator in proportion to the steam supplied to obtain hot water of given temperature, means to withdraw hot water from said accumulator at a rate corresponding to the rate of demand for hot water, the difference between the hot water demand and the hot water produced being retained in the accumulator.

2. In a steam plant, in combination, a steam generator, a steam consumer, a constant temperature, variable water level accumulator, means to conduct steam from said generator to said steam consumer, means to conduct the surplus of steam not consumed above that generated to said accumulator, means to supply cold water to said accumulator, automatic means to regulate the amount of cold water supplied to maintain a constant temperature in said accumulator and means to withdraw hot water from said accumulator.

3. In a steam plant, in combination, a steam generator, a constant temperature variable water level accumulator, a passage for steam from said generator to said accumulator, valve mechanism in said passage operating to maintain a constant pressure in the steam generator, means to supply cold

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water to said accumulator, automatic means to control the cold water supply in response to temperature in the accumulator and means to conduct hot water from said accumulator to said steam generator.

4. In a steam plant, in combination, a steam boiler, a variable supply of waste heat for said steam boiler, a constant temperature, variable water level accumulator, a passage for steam from said boiler to said accumulator, valve mechanism in said passage operating to maintain a constant pressure in the boiler, means to supply cold water to said accumulator and operating to maintain a constant temperature in the accumulator, hot water consumers and means to conduct hot water from said accumulator to said hot water consumers.

5. In a steam plant, in combination, a steam generator, a constant temperature, variable water level accumulator, a passage for steam from said generator to said accumulator, valve mechanism in said passage operating to maintain a constant pressure in the steam generator, means to supply cold water to said accumulator, automatic means to control the cold water supply and operating to maintain a constant temperature in said accumulator, an indicator mounted in the vicinity of said steam generator and mechanism responsive to changes of water level in said accumulator and indicating said changes upon said indicator.

6. In a steam plant, in combination, a steam generator, a steam consumer, a constant temperature, variable water level accumulator, means to conduct steam from said generator to said steam consumer, means to conduct the surplus of steam not consumed above that generated to said accumulator, means to control the last mentioned means and operating to maintain a constant pressure in the generator, means to supply cold water to said accumulator, automatic means to regulate the amount of cold water supplied to maintain a constant temperature in said accumulator, means to extract and use hot water from said accumulator, means to condense steam passing through said steam consumer, and means to conduct condensate thus produced to said accumulator.

7. In a steam plant, in combination, a steam generator, a constant temperature, variable water level accumulator, a passage for steam from said generator to said accumulator, a valve controlling said passage, and means operated by a predetermined high level of water in said accumulator to close said valve.

8. In a steam plant, in combination, a steam generator, a steam consumer, a constant temperature, variable water level accumulator, means to conduct steam from said generator to said steam consumer, means to conduct steam from said generator to said accumulator, means to condense steam used in said steam consumer, a container, means to conduct the condensate to said container, means to supply cold water to said accumulator from an outside source, means to supply water from said container to said accumulator, and means responsive to height of liquid in said container to cut off the supply from the outside source.

9. The method of generating and dispensing energy in a steam plant which comprises generating steam at constant pressure and normally in excess of steam demand, condensing the surplus steam by means of cold water, regulating the supply of cold water so that the hot water produced by the mixing of steam and cold water is maintained at constant temperature, accumulating hot water thus produced and using the hot water as desired.

10. In a steam plant including a steam generator, in combination, a constant temperature, variable water level accumulator containing water at different heights for different times, means to supply surplus steam generated over momentary steam demand to said accumulator, means to supply cold water to said accumulator to condense said steam and produce hot water, said accumulator being constructed and arranged to store the hot water produced until there is a demand for the hot water, and means responsive to the temperature in the accumulator to control the supply of cold water and operating to normally maintain a constant temperature in the accumulator.

11. In a steam plant including a steam generator, in combination, a constant temperature, variable water level accumulator containing water at different heights for different times, said accumulator comprising a receptacle closed to the atmosphere and adapted to operate at different pressures than atmospheric pressure and containing a steam space and a water space, a steam charging device in the water space of the accumulator, means to supply surplus steam generated over momentary steam demand to said steam charging device, means to supply cold water to said accumulator to condense said steam and produce hot water, said accumulator being constructed and arranged to store the hot water produced until there is a demand for the hot water and means responsive to the temperature in the accumulator to control the supply of cold water and operating to normally maintain a constant temperature in the accumulator.

12. In a steam plant, in combination, a steam generator, a constant temperature variable water level accumulator, a passage for steam from said generator to said accumulator, valve mechanism in said passage operating to maintain a constant pressure

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in the steam generator, means to supply cold water to said accumulator, automatic means to control the cold water supply in response to temperature in the accumulator, a hot water consumer and means to conduct hot water from said accumulator to said consumer.

13. The method of operating a steam plant which comprises generating steam at a different rate than the rate of consumption, condensing the surplus steam by means of cold water, regulating the supply of cold water so that the hot water produced by the mixing of steam and cold water is maintained at constant temperature, accumulating hot water thus produced in an accumulator, indicating the height of water in the accumulator and controlling the supply of heat to the generator in accordance with the indicated height of water in the accumulator.

14. In a steam plant, an accumulator having a water space and a steam space, means to supply steam to said accumulator, means to supply cold water to said accumulator to condense said steam and produce hot water, said accumulator being constructed and arranged to store the hot water produced until there is a demand for hot water, means to withdraw hot water from said accumulator, means to withdraw steam from said accumulator, and means to control the supply of cold water to maintain a constant temperature and pressure in the accumulator except when steam is withdrawn.

15. In a steam plant, an accumulator having a water space and a steam space, means to supply steam to said accumulator, means to supply cold water to said accumulator to condense said steam and produce hot water, said accumulator being constructed and arranged to store the hot water produced until there is a demand for hot water, means to withdraw hot water from said accumulator, means to withdraw steam from said accumulator and means for controlling the supply of cold water to maintain a constant temperature and pressure in the accumulator when steam is not withdrawn, to shut off the cold water supply when steam is withdrawn and the pressure and temperature drop, and to admit cold water when the pressure and temperature rise again and a given value of temperature is reached.

16. In a steam plant, in combination, a steam generator, an accumulator comprising a receptacle closed to the atmosphere and having a steam space and a water space, a passage for steam from said generator to said accumulator, valve mechanism in said passage operating to maintain a constant pressure in said steam generator, means to supply cold water to said accumulator to condense said steam and produce hot water, said accumulator being constructed and arranged to store the hot water produced until there is a demand for hot water, means to withdraw hot water from said accumulator, means to withdraw steam from said accumulator, and means to control the supply of cold water to maintain a constant temperature and pressure in the accumulator except when steam is withdrawn.

17. In a steam plant, in combination, a steam generator, an accumulator having a steam space and a water space, a passage for steam from said generator to said accumulator, valve mechanism in said passage operating to maintain a constant pressure in said steam generator, means to supply cold water to said accumulator to condense said steam and produce hot water, said accumulator being constructed and arranged to store the hot water produced until there is a demand for hot water, means to withdraw hot water from said accumulator, means to withdraw steam from said accumulator, and means to control the supply of cold water to maintain a constant temperature and pressure in the accumulator except when steam is withdrawn, and means for controlling the supply of cold water to maintain a constant temperature and pressure in the accumulator when steam is not withdrawn, to shut off the cold water supply when steam is withdrawn and the pressure and temperature drop, and to admit cold water when the pressure and temperature rise again and a given value of temperature is reached.

18. Accumulator apparatus for steam plants including a steam generator comprising a receptacle closed to the atmosphere and having a steam space and a water space and adapted to operate at pressures different than atmospheric, means to supply surplus generated steam over momentary steam demand to said receptacle, means to supply cold water to said receptacle and automatic means normally operating to control the cold water supply to maintain a constant temperature in said receptacle.

In testimony whereof I hereunto affix my signature.

JOHANNES RUTHS.